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(12) **United States Patent**
**Christopher**

(10) **Patent No.: US 9,111,157 B2**
(45) **Date of Patent: Aug. 18, 2015**

(54) **SYSTEM AND METHOD FOR TRACKING SHOPPING BEHAVIOR**

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(72) Inventor: **James Christopher**, La Mesa, CA (US)

(73) Assignee: **INSIGHT HOLDING GROUP, INC.**, La Mesa, CA (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 94 days.

(21) Appl. No.: **13/889,184**

(22) Filed: **May 7, 2013**

(65) **Prior Publication Data**

US 2013/0293355 A1 Nov. 7, 2013

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 13/479,723, filed on May 24, 2012, now Pat. No. 8,441,351, which is a continuation of application No. 11/853,223, filed on Sep. 11, 2007, now Pat. No. 8,207,851, which is a continuation-in-part of application No. 11/782,402, filed on Jul. 24, 2007, now Pat. No. 8,138,919, which is a continuation-in-part of application No. 11/683,903, filed on Mar. 8, 2007, now Pat. No. 7,772,976, which is a continuation-in-part of application No. 11/505,616, filed on Aug. 16, 2006, now Pat. No. 7,683,782, and a continuation-in-part of application No. 11/506,179, filed on Aug. 16, 2006, now Pat. No. 7,728,729.

(51) **Int. Cl.**

| | |
|---|---|
| ***H04Q 5/22*** | (2006.01) |
| ***G08B 13/14*** | (2006.01) |
| ***G06K 7/10*** | (2006.01) |
| ***G06Q 30/02*** | (2012.01) |
| ***G07C 9/00*** | (2006.01) |
| *G06K 17/00* | (2006.01) |

(52) **U.S. Cl.**
CPC ............ ***G06K 7/10376*** (2013.01); ***G06Q 30/02*** (2013.01); ***G06Q 30/0201*** (2013.01); ***G06Q 30/0241*** (2013.01); ***G07C 9/00111*** (2013.01); *G06K 2017/0045* (2013.01)

(58) **Field of Classification Search**
CPC .......... G06K 19/07749; G06K 7/0008; G06K 19/0723; G08B 13/2434; G06Q 30/0241; G06Q 30/02
USPC ............... 340/1.41, 5.91, 539.13, 988, 572.2, 340/572.1, 568.5, 573.1, 539.16, 539.17, 340/568.1, 10.41, 572.8; 342/46; 701/218; 235/385, 383, 462.13
See application file for complete search history.

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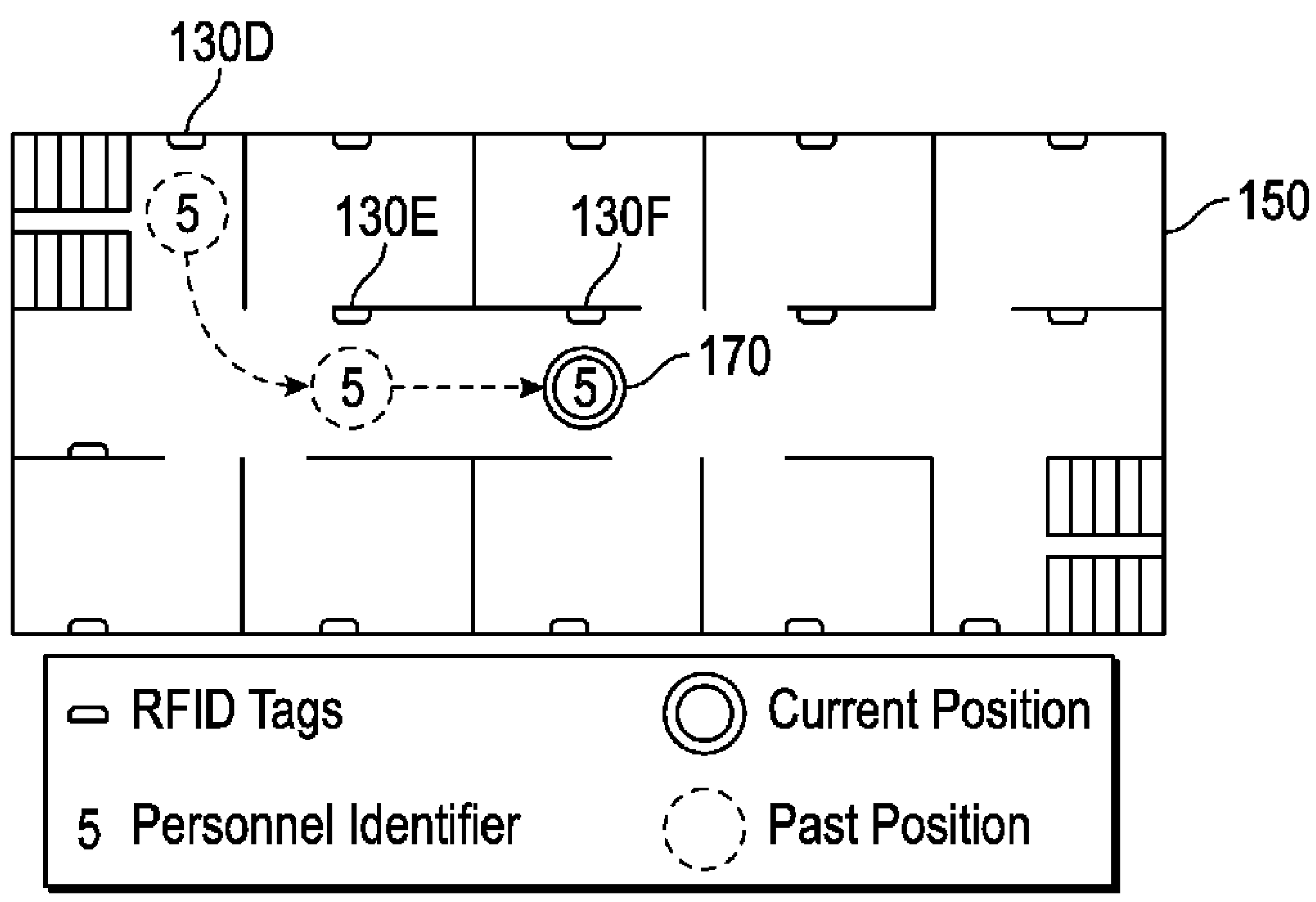
*Primary Examiner* — Hoi Lau
(74) *Attorney, Agent, or Firm* — Sheppard Mullin Richter & Hampton LLP

(57) **ABSTRACT**

A system and method are provided for tracking an interrogator relay unit (IRU) associated with a mobile asset within a structure, comprising: integrating one or more RFID tags within building materials within the structure; emitting an RF interrogation signal using the IRU; receiving, at the IRU, location data from one or more RFID tags in response to the RF interrogation signal; and transmitting the location data, an identification information of the IRU, and timestamp data to a remote server using the IRU.

**6 Claims, 24 Drawing Sheets**



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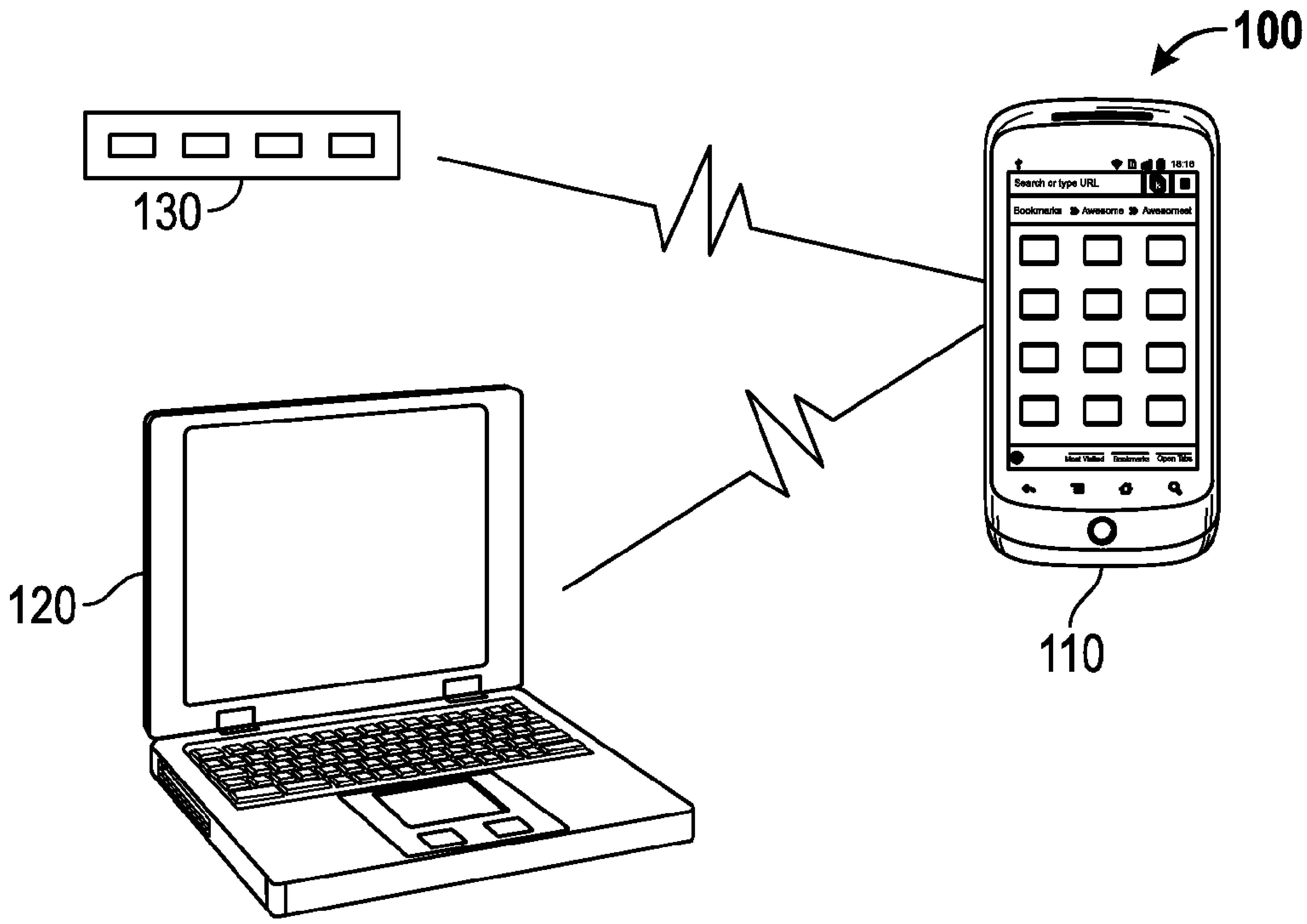

100
130
120
110

FIG. 1

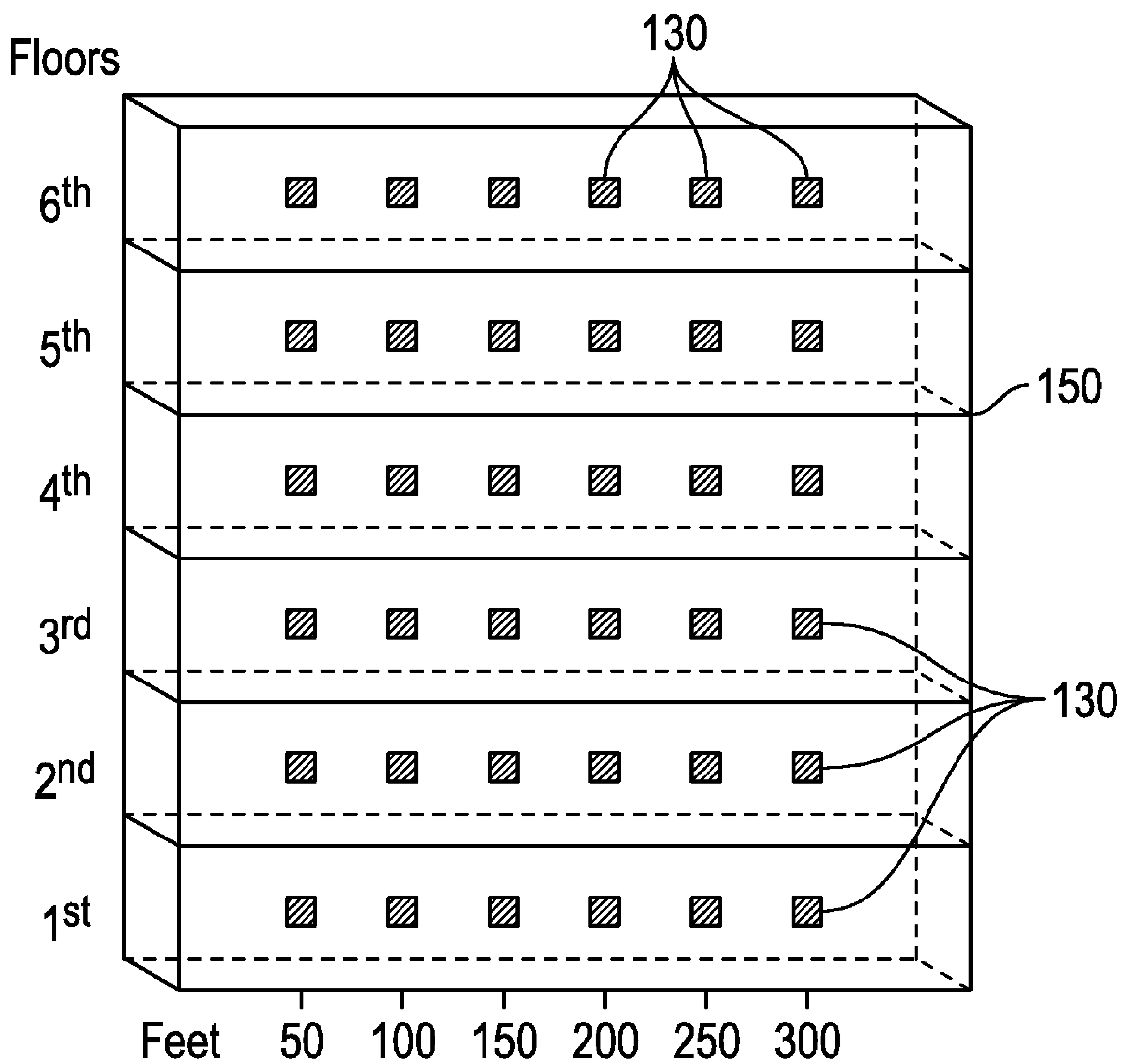

Floors
130
6th
5th
4th
3rd
2nd
1st
150
130
Feet
50
100
150
200
250
300

FIG. 2A

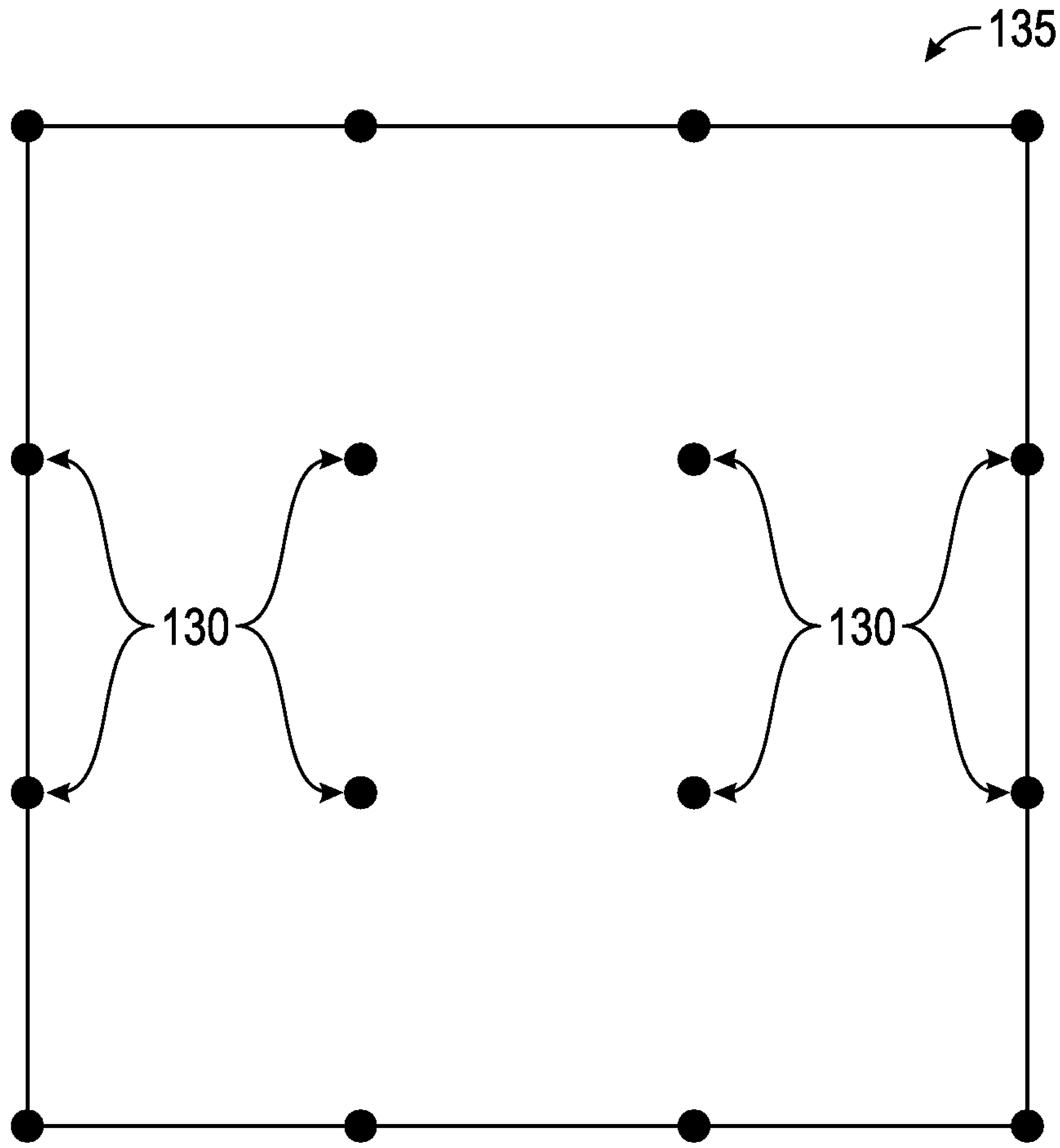



FIG. 2B

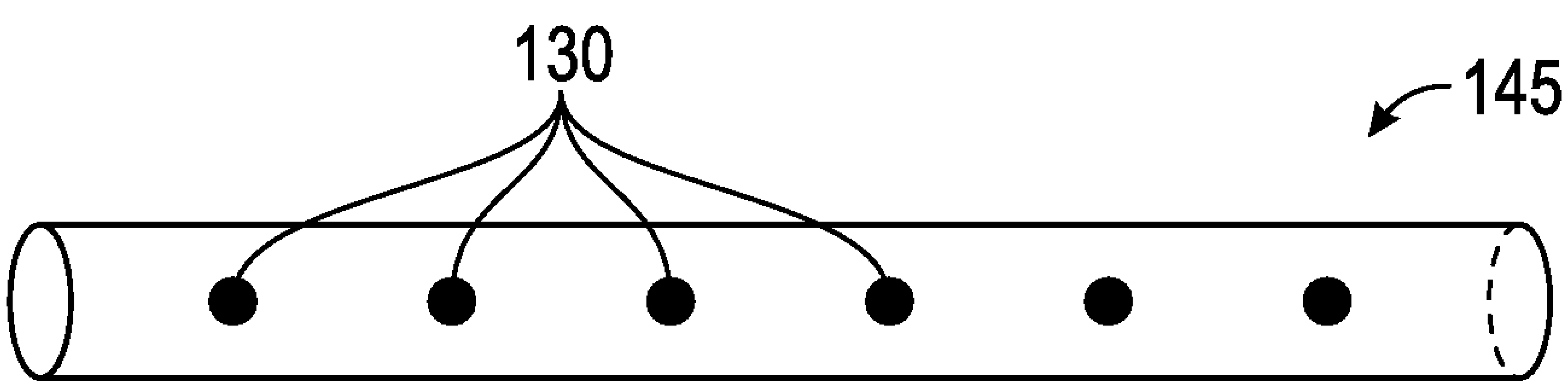



FIG. 2C

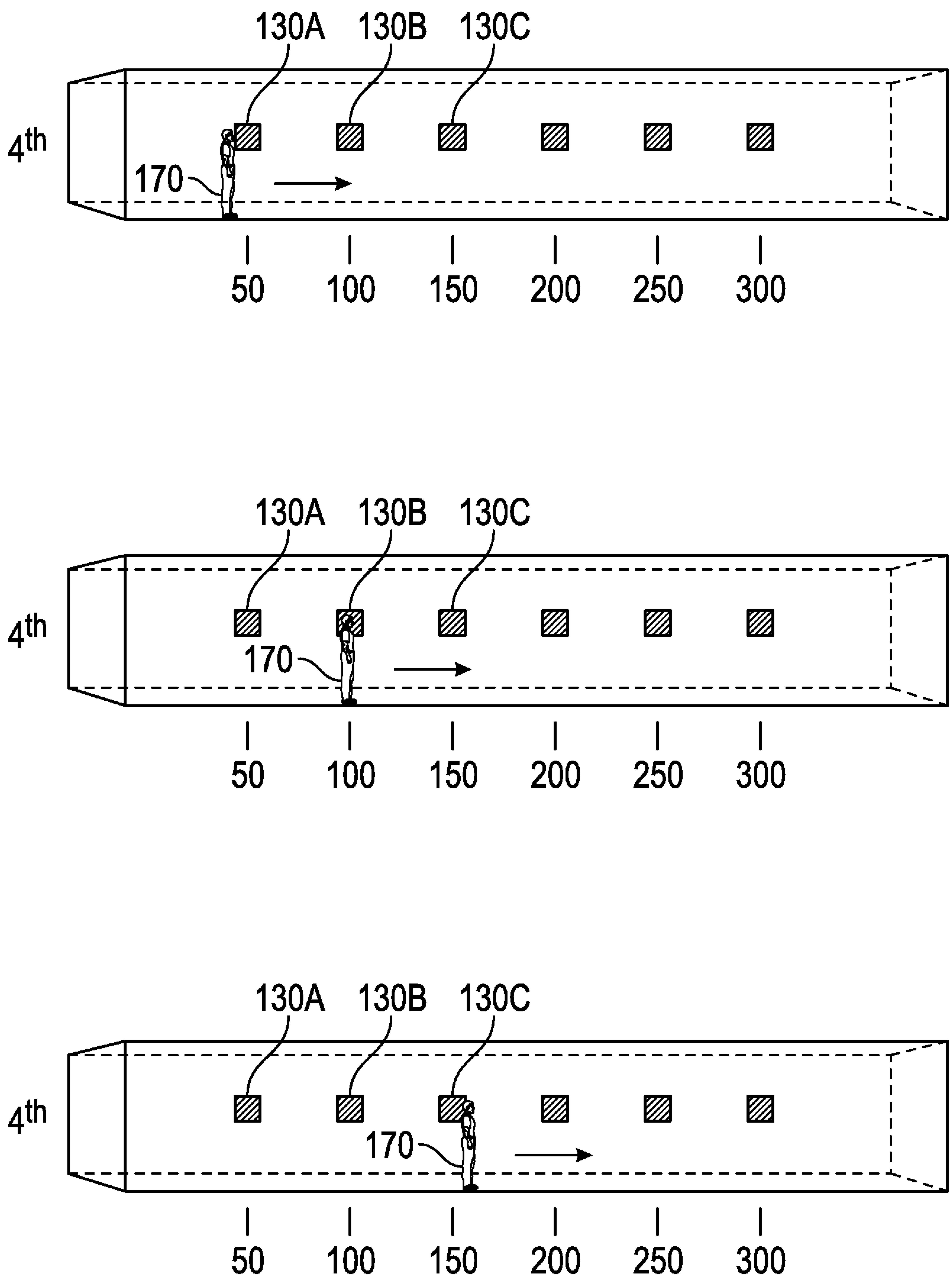

130A
130B
130C
4th
170
50
100
150
200
250
300
130A
130B
130C
4th
170
50
100
150
200
250
300
130A
130B
130C
4th
170
50
100
150
200
250
300

FIG. 3

190

Name: Fireman #5 Log Time: 27 July 2006

Building: ACME Corporate offices
Building Adress: 1313 First Ave.
New York, NY 1001

| Floor | Tag# | Time | Location |
|---|---|---|---|
| 1 | 1-1 | 12:01:00 | Entrance - West |
| 2 | 2-1 | 12:02:00 | Stairwell - West Wall |
| 3 | 3-1 | 12:03:00 | Stairwell - West Wall |
| 4 | 4-1 | 12:04:00 | Stairwell - West Wall |
| 4 | 4-50 | 12:04:10 | Main Corridor - 50ft From West Wall |
| 4 | 4-100 | 12:04:20 | Main Corridor - 100ft From West Wall |
| 4 | 4-150 | 12:04:30 | Main Corridor - 150ft From West Wall |
| | | | |
| | | | |
| | | | |

FIG. 4

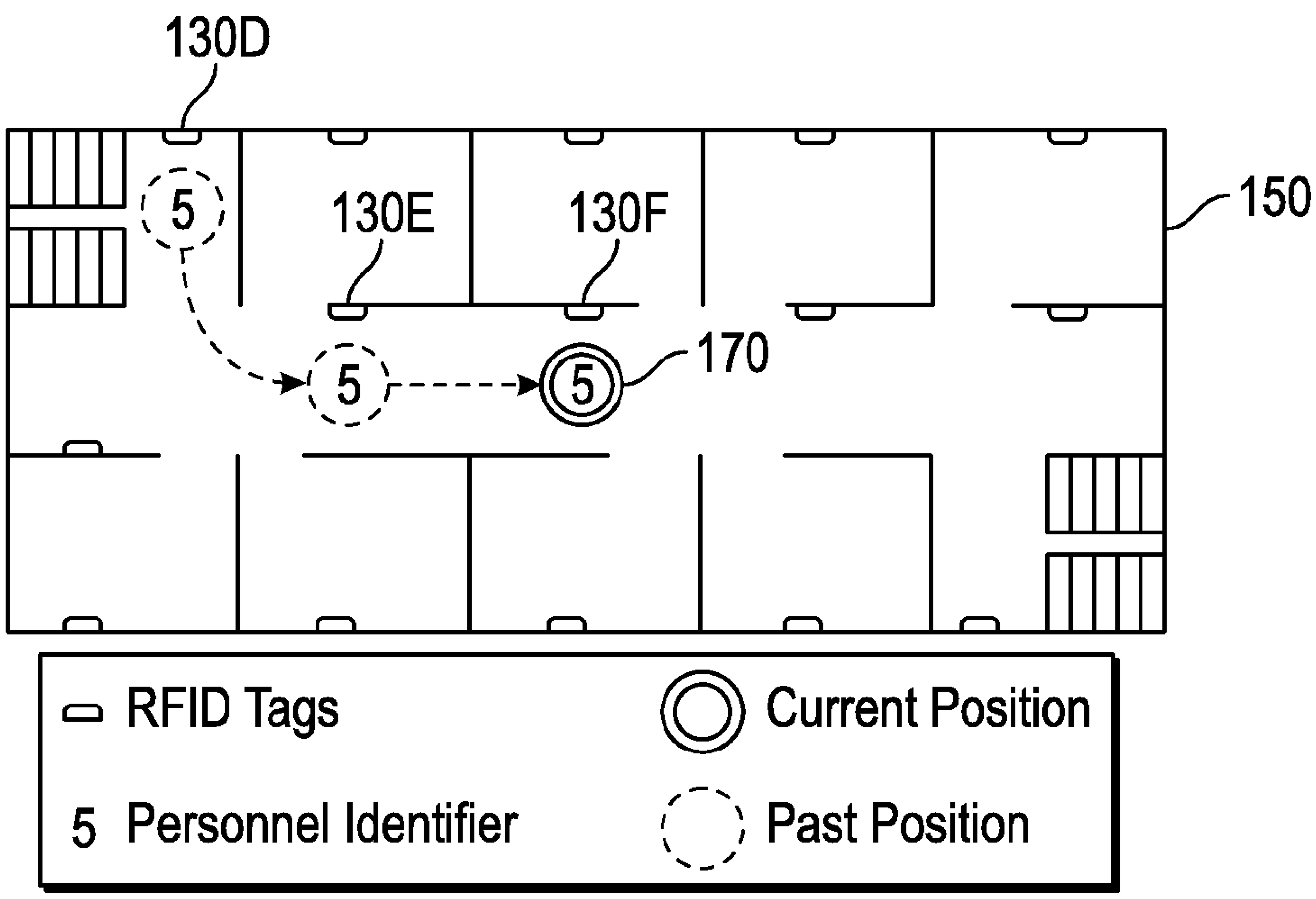



FIG. 5

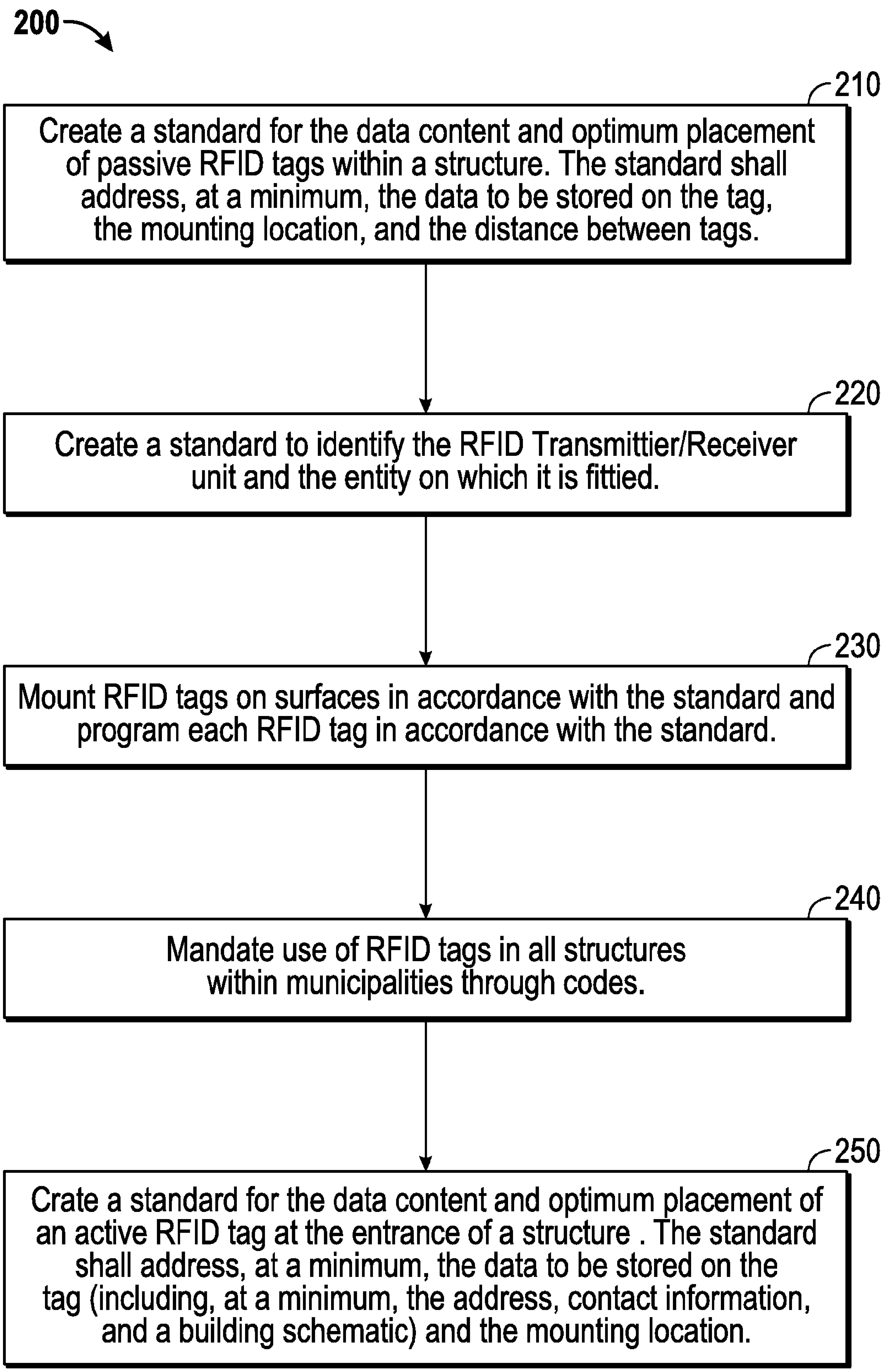

200
210
Create a standard for the data content and optimum placement of passive RFID tags within a structure. The standard shall address, at a minimum, the data to be stored on the tag, the mounting location, and the distance between tags.
220
Create a standard to identify the RFID Transmittier/Receiver unit and the entity on which it is fittied.
230
Mount RFID tags on surfaces in accordance with the standard and program each RFID tag in accordance with the standard.
240
Mandate use of RFID tags in all structures within municipalities through codes.
250
Crate a standard for the data content and optimum placement of an active RFID tag at the entrance of a structure . The standard shall address, at a minimum, the data to be stored on the tag (including, at a minimum, the address, contact information, and a building schematic) and the mounting location.

FIG. 6

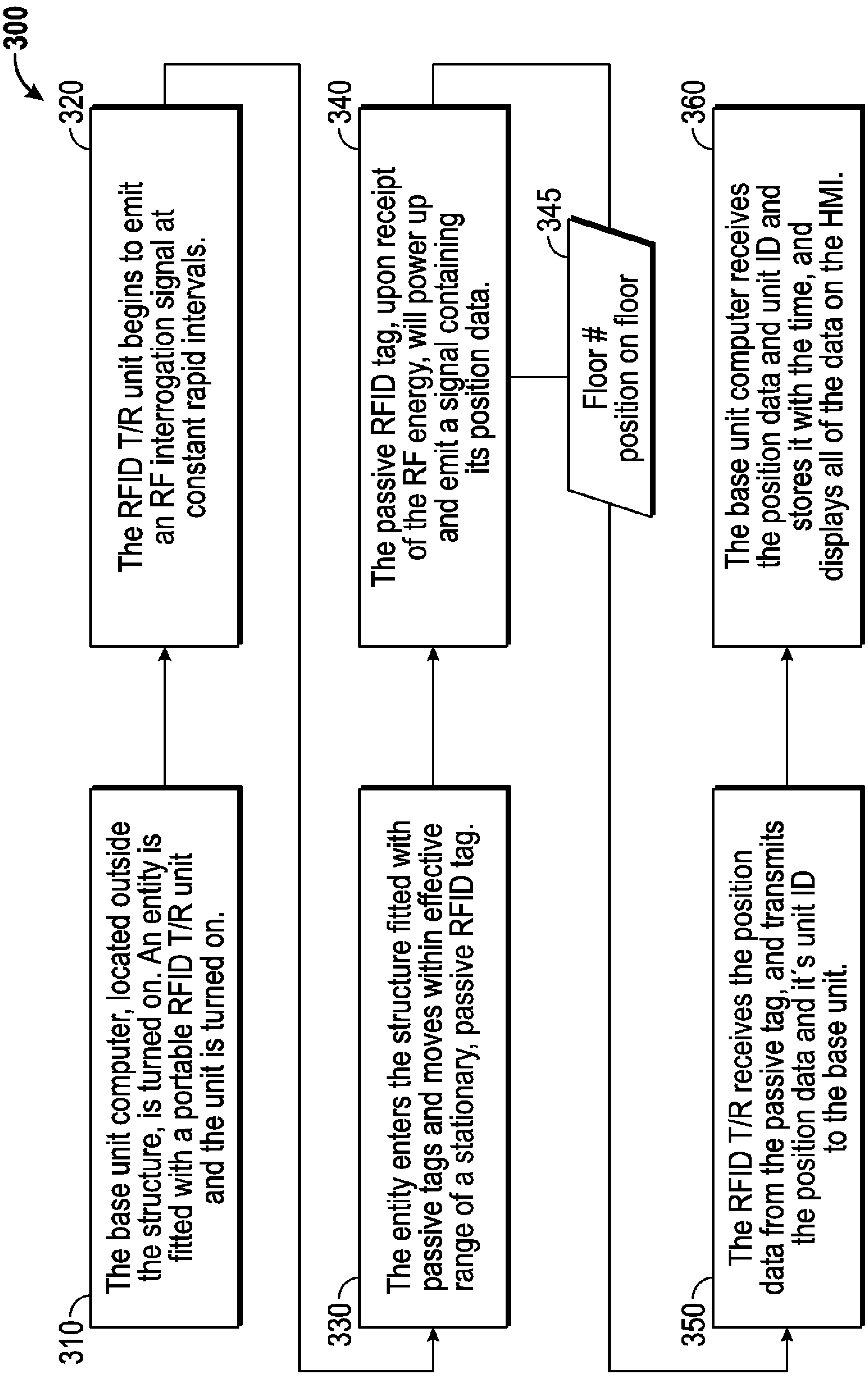

300
310
The base unit computer, located outside the structure, is turned on. An entity is fitted with a portable RFID T/R unit and the unit is turned on.
320
The RFID T/R unit begins to emit an RF interrogation signal at constant rapid intervals.
330
The entity enters the structure fitted with passive tags and moves within effective range of a stationary, passive RFID tag.
340
The passive RFID tag, upon receipt of the RF energy, will power up and emit a signal containing its position data.
345
Floor # position on floor
350
The RFID T/R receives the position data from the passive tag, and transmits the position data and it's unit ID to the base unit.
360
The base unit computer receives the position data and unit ID and stores it with the time, and displays all of the data on the HMI.

FIG. 7

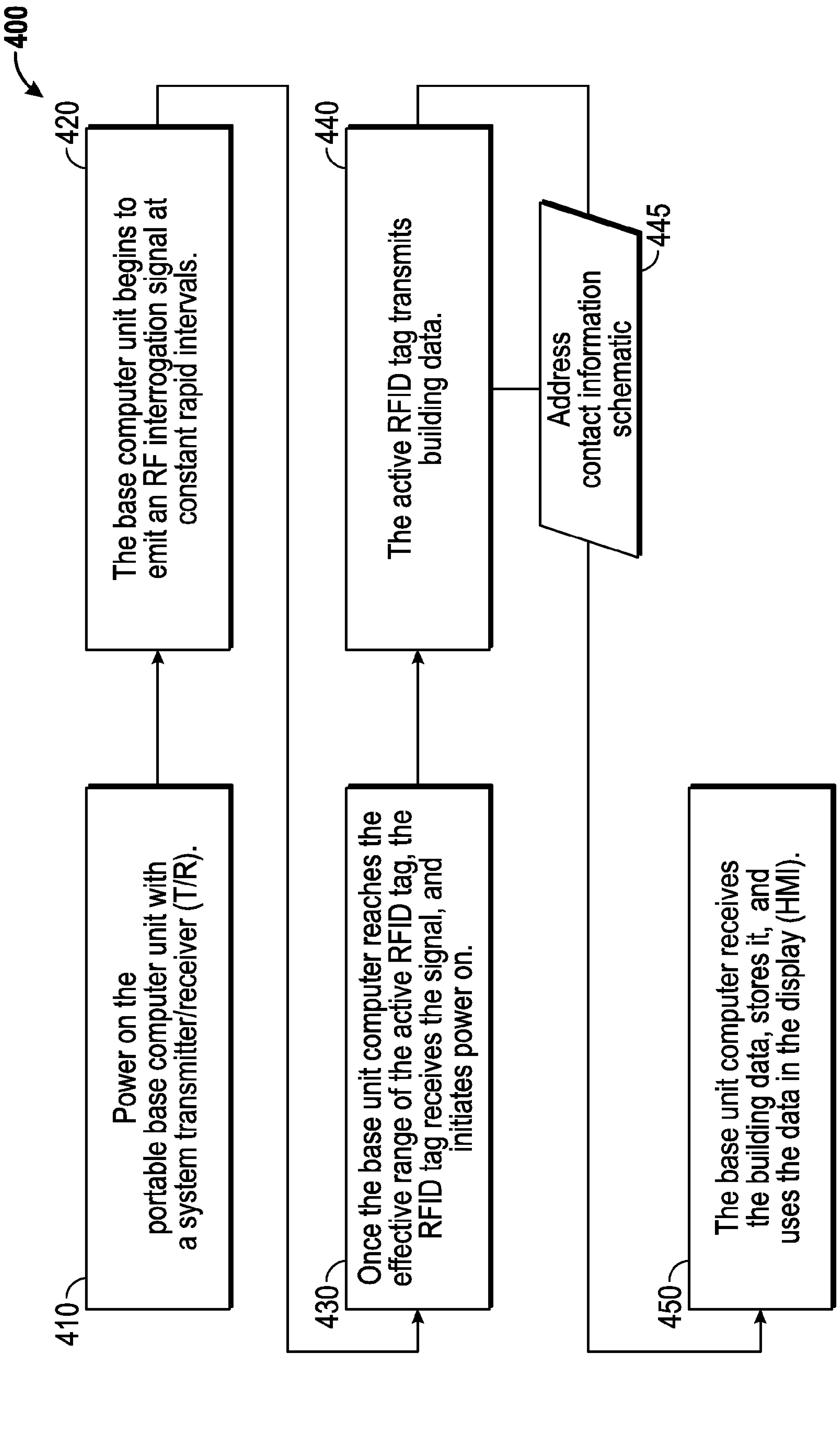

400
410
Power on the portable base computer unit with a system transmitter/receiver (T/R).
420
The base computer unit begins to emit an RF interrogation signal at constant rapid intervals.
430
Once the base unit computer reaches the effective range of the active RFID tag, the RFID tag receives the signal, and initiates power on.
440
The active RFID tag transmits building data.
445
Address contact information schematic
450
The base unit computer receives the building data, stores it, and uses the data in the display (HMI).

FIG. 8

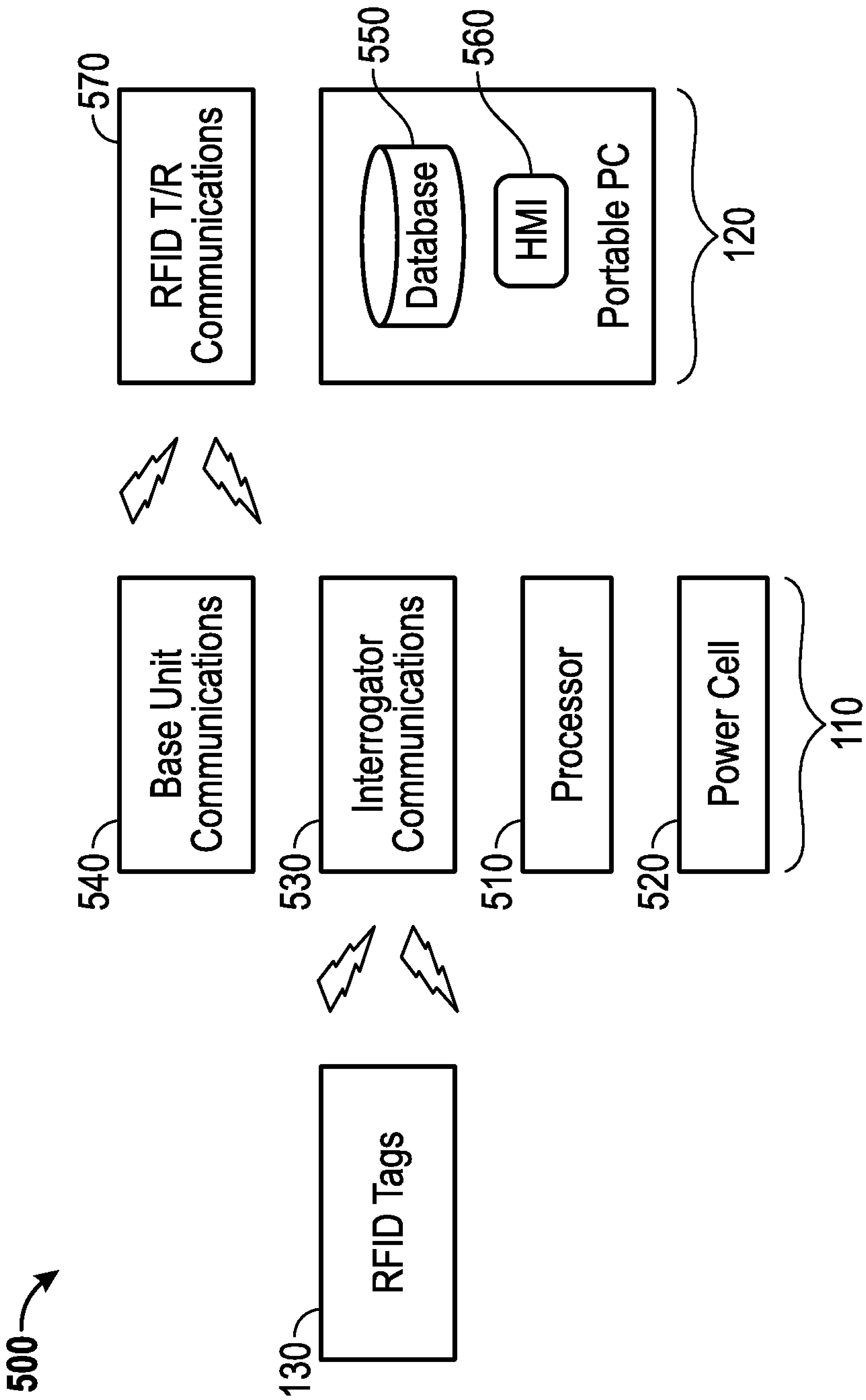

500
RFID Tags
130
Interrogator Communications
530
Base Unit Communications
540
Processor
510
Power Cell
520
110
RFID T/R Communications
570
Database
550
HMI
560
Portable PC
120

FIG. 9

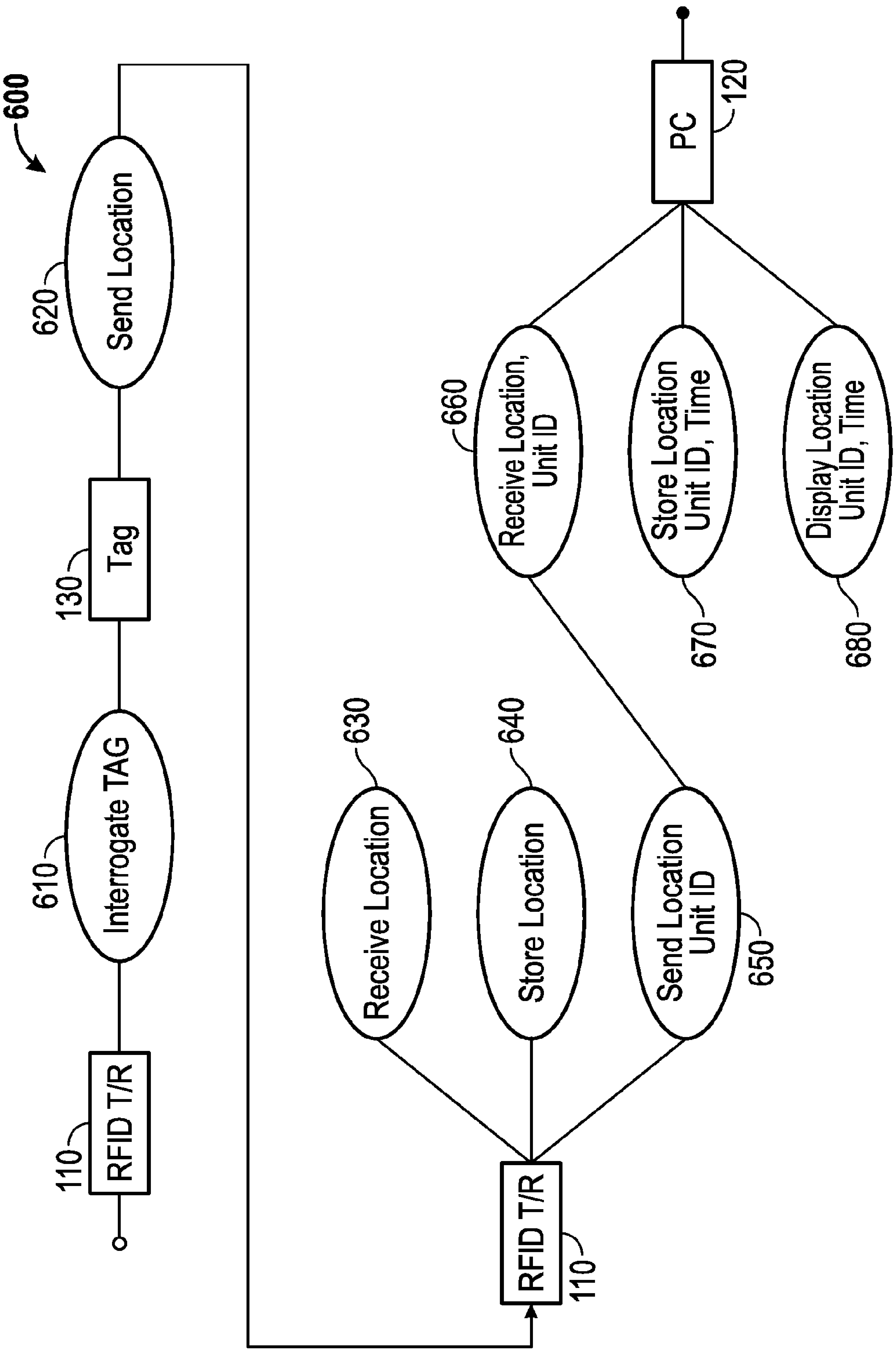

600
RFID T/R
110
Interrogate TAG
610
Tag
130
Send Location
620
RFID T/R
110
Receive Location
630
Store Location
640
Send Location
Unit ID
650
Receive Location,
Unit ID
660
Store Location
Unit ID, Time
670
Display Location
Unit ID, Time
680
PC
120

FIG. 10

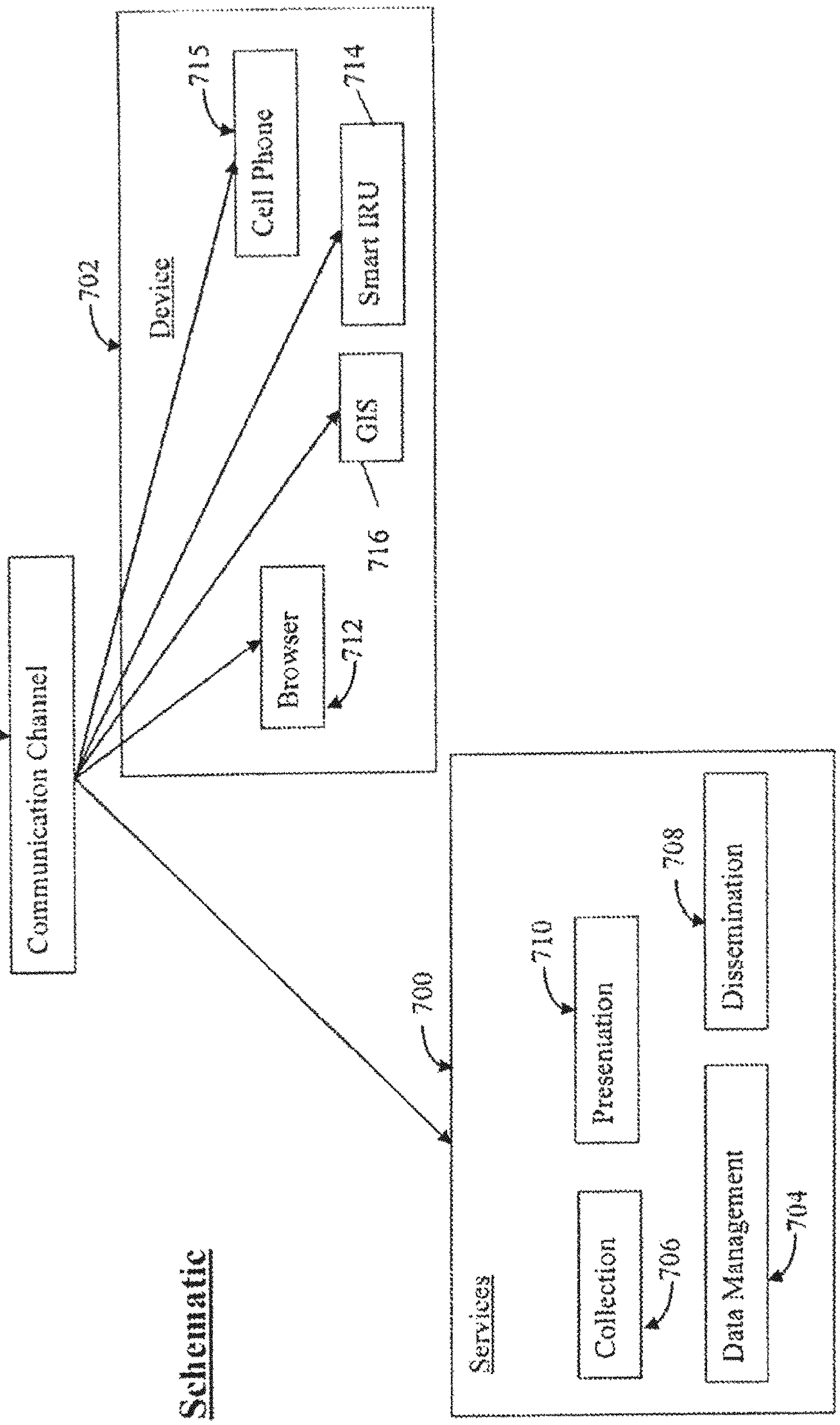
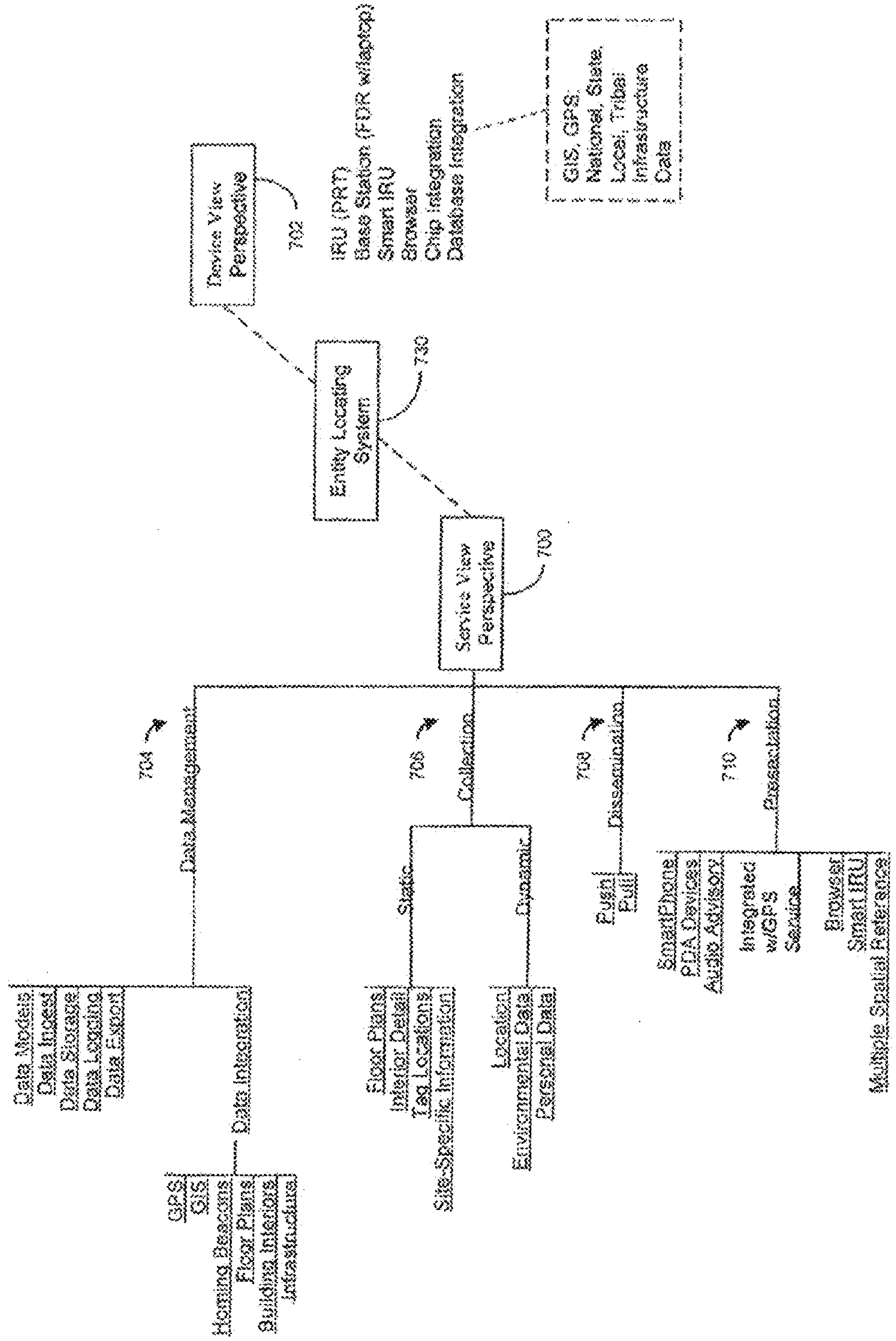

Schematic
Communication Channel
720
Device
702
Cell Phone
715
Smart IRU
714
GIS
716
Browser
712
Services
700
Presentation
710
Dissemination
708
Collection
706
Data Management
704

FIG. 11



Device View Perspective
702
IRU (PRT)
Base Station (FDR w/laptop)
Smart IRU
Browser
Chip Integration
Database Integration
GIS, GPS, National, State, Local, Tribal Infrastructure Data
Entity Locating System
730
Service View Perspective
700
704
Data Management
706
Collection
708
Dissemination
710
Presentation
Data Models
Data Ingest
Data Storage
Data Logging
Data Export
Data Integration
GPS
GIS
Homing Beacons
Floor Plans
Building Interiors
Infrastructure
Static
Dynamic
Floor Plans
Interior Detail
Tag Locations
Site-Specific Information
Location
Environmental Data
Personal Data
Push
Pull
SmartPhone
PDA Devices
Audio Advisory
Integrated w/GPS Service
Browser
Smart IRU
Multiple Spatial Reference


FIG. 12

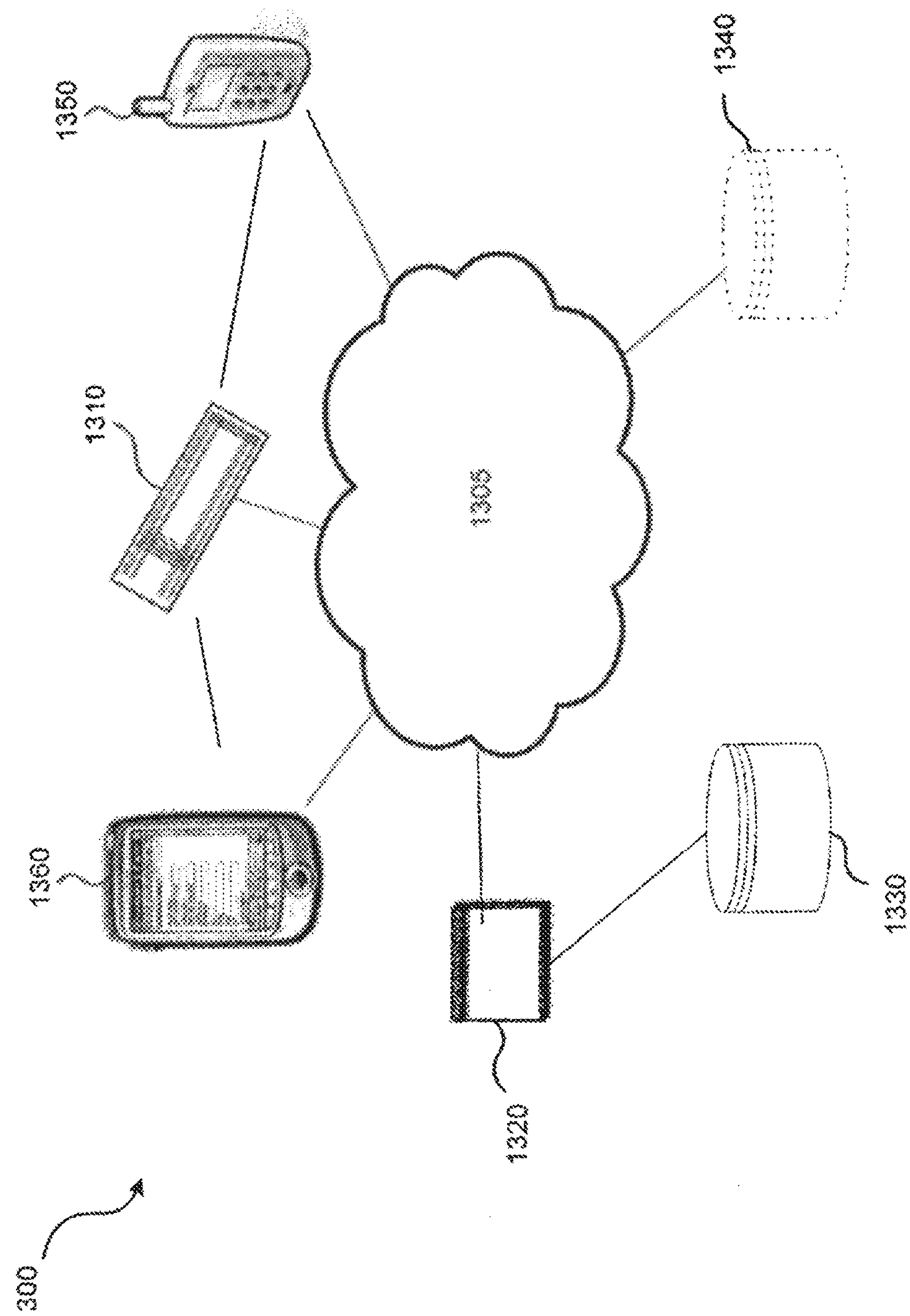



FIG. 13A

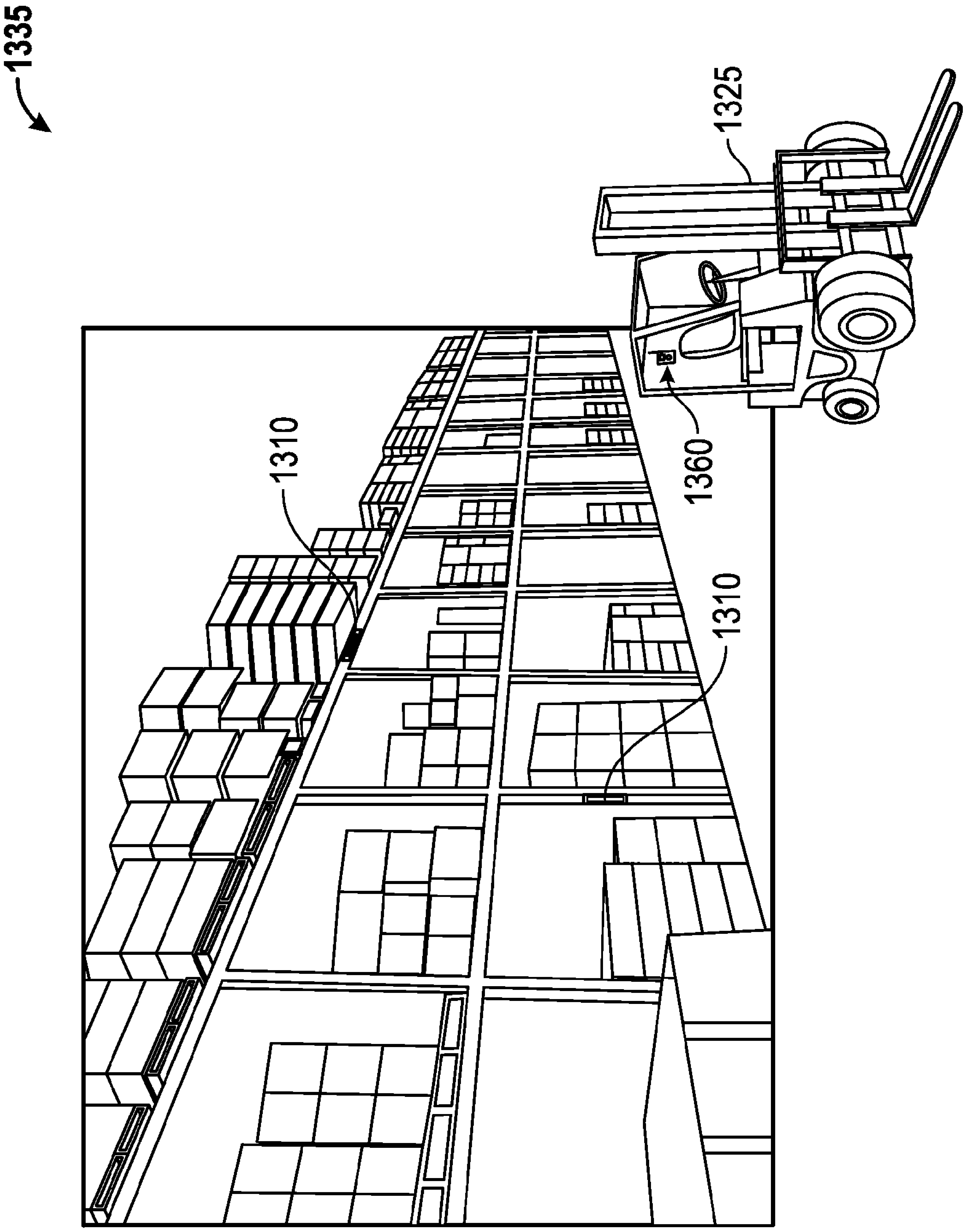



FIG. 13B

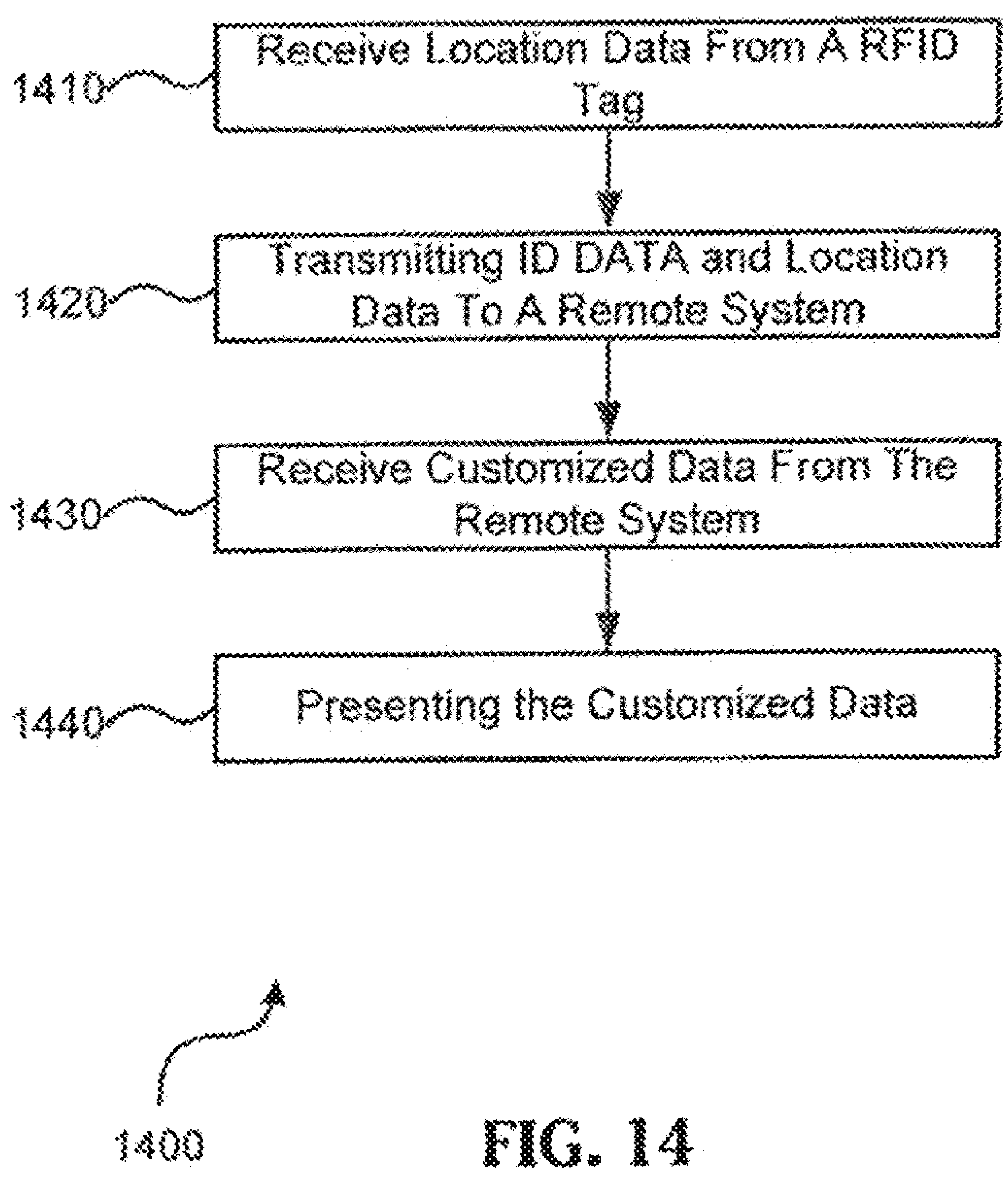

1410
Receive Location Data From A RFID Tag
1420
Transmitting ID DATA and Location Data To A Remote System
1430
Receive Customized Data From The Remote System
1440
Presenting the Customized Data
1400

FIG. 14

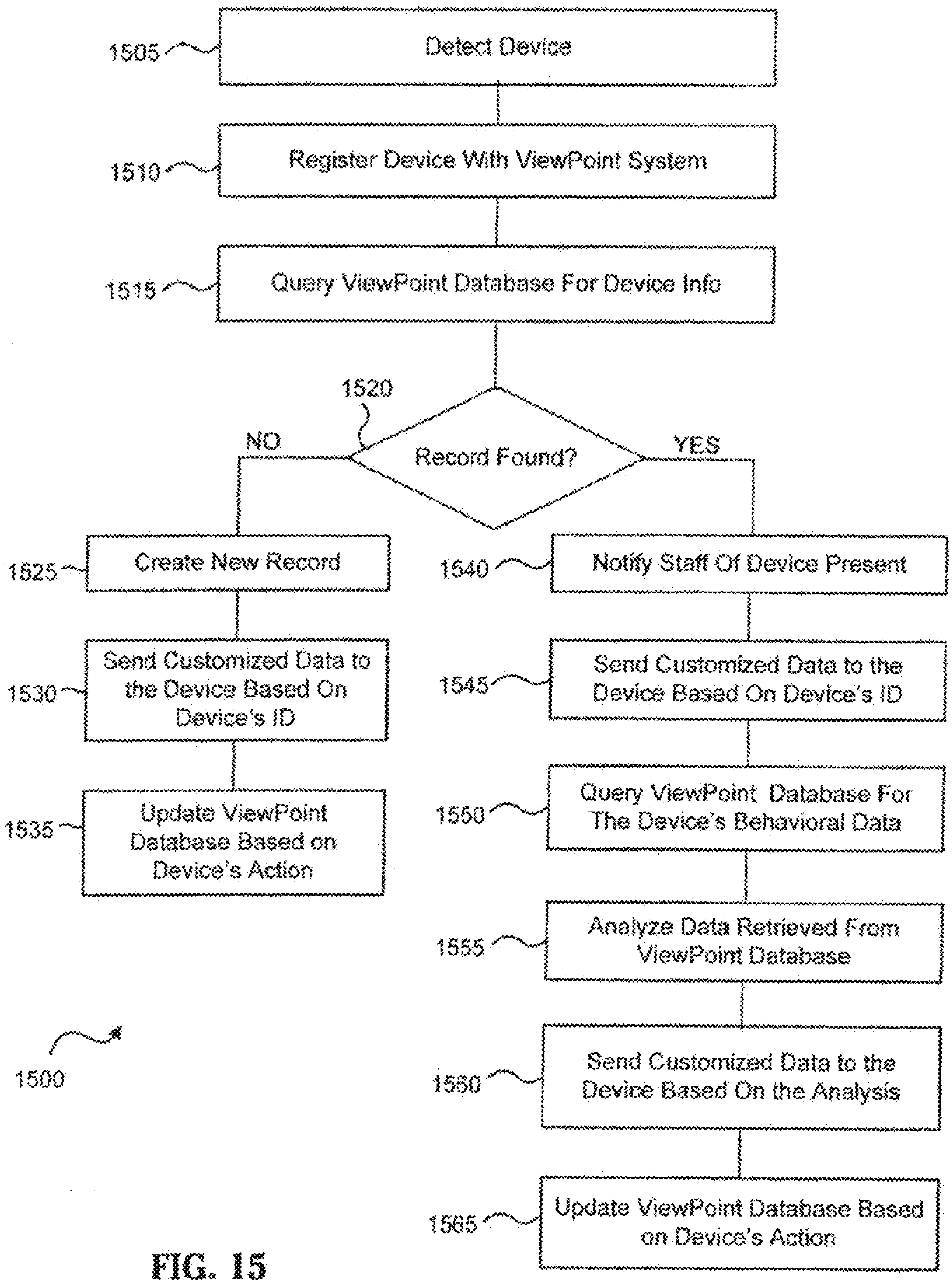

1505
Detect Device
1510
Register Device With ViewPoint System
1515
Query ViewPoint Database For Device Info
1520
Record Found?
NO
YES
1525
Create New Record
1530
Send Customized Data to the Device Based On Device's ID
1535
Update ViewPoint Database Based on Device's Action
1540
Notify Staff Of Device Present
1545
Send Customized Data to the Device Based On Device's ID
1550
Query ViewPoint Database For The Device's Behavioral Data
1555
Analyze Data Retrieved From ViewPoint Database
1560
Send Customized Data to the Device Based On the Analysis
1565
Update ViewPoint Database Based on Device's Action
1500

FIG. 15

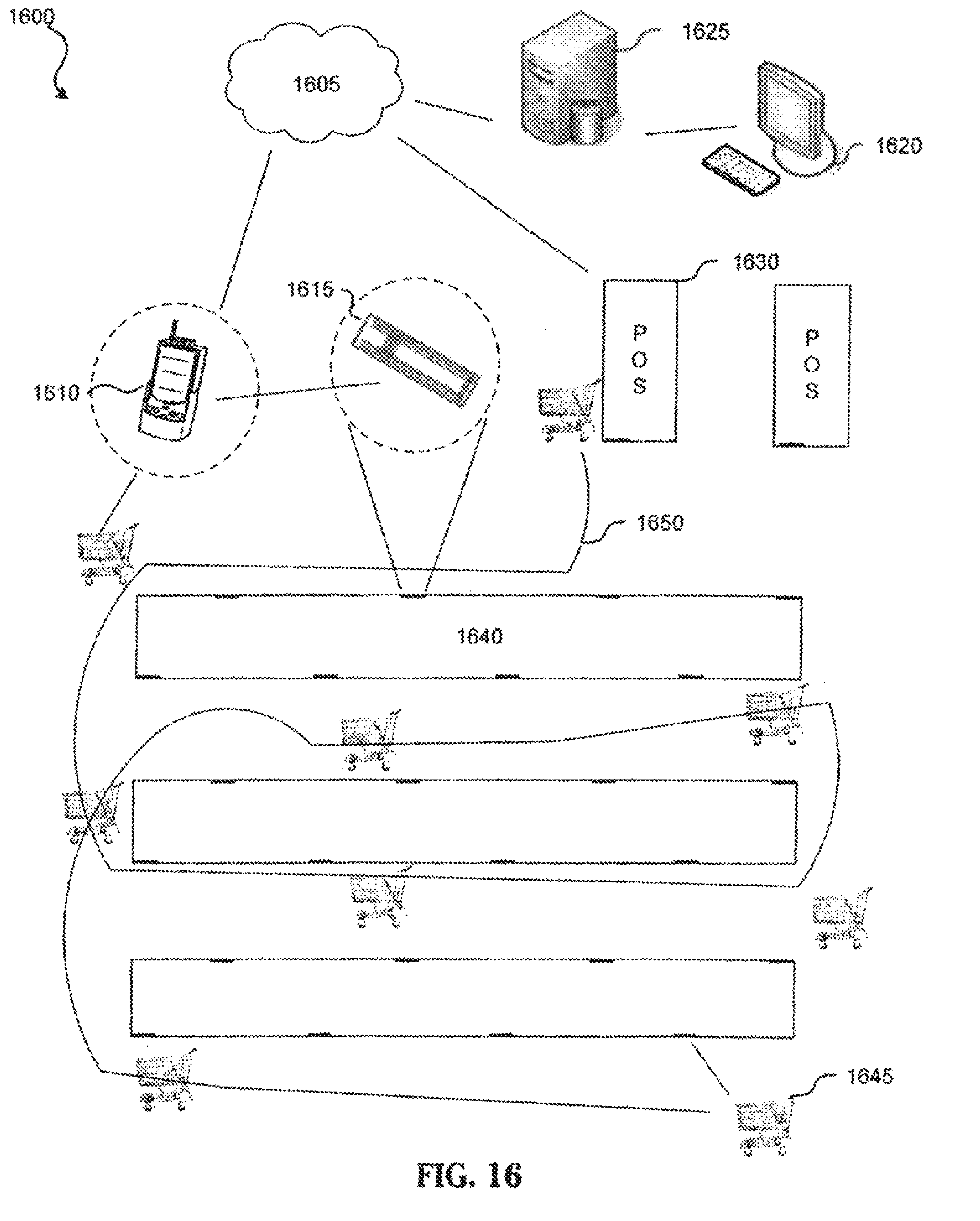



FIG. 16

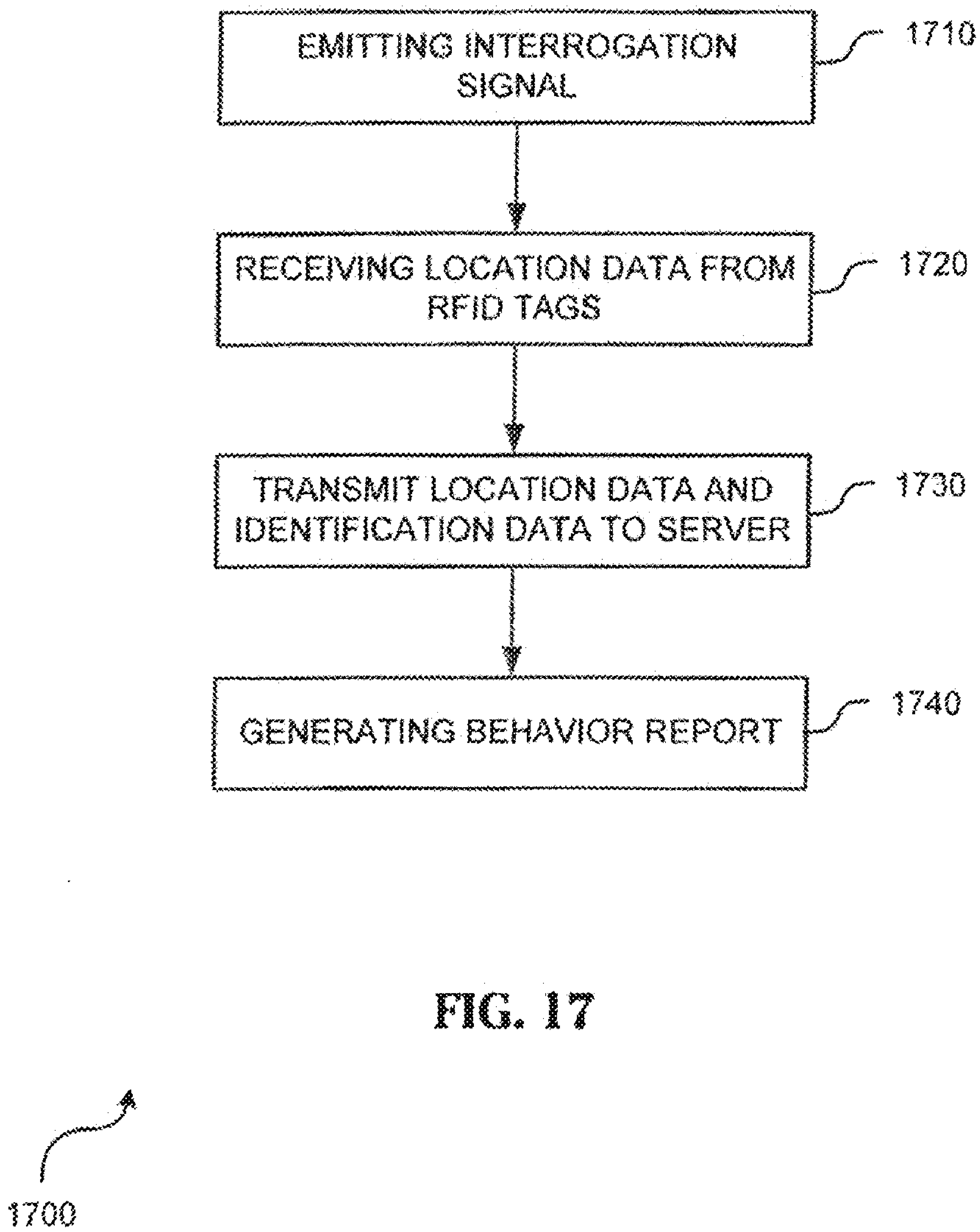

EMITTING INTERROGATION SIGNAL
1710
RECEIVING LOCATION DATA FROM RFID TAGS
1720
TRANSMIT LOCATION DATA AND IDENTIFICATION DATA TO SERVER
1730
GENERATING BEHAVIOR REPORT
1740
1700

FIG. 17

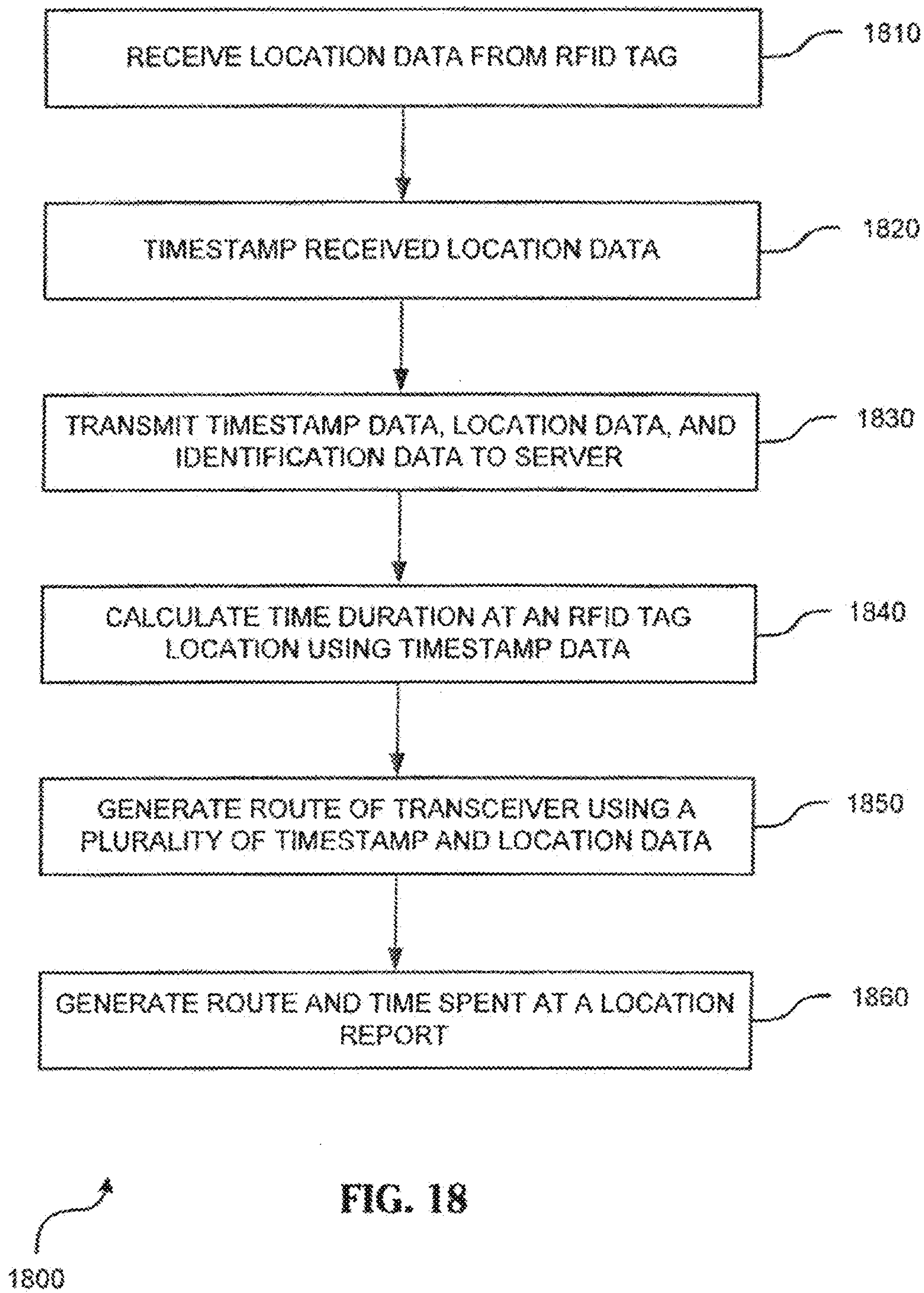

RECEIVE LOCATION DATA FROM RFID TAG
1810
TIMESTAMP RECEIVED LOCATION DATA
1820
TRANSMIT TIMESTAMP DATA, LOCATION DATA, AND IDENTIFICATION DATA TO SERVER
1830
CALCULATE TIME DURATION AT AN RFID TAG LOCATION USING TIMESTAMP DATA
1840
GENERATE ROUTE OF TRANSCEIVER USING A PLURALITY OF TIMESTAMP AND LOCATION DATA
1850
GENERATE ROUTE AND TIME SPENT AT A LOCATION REPORT
1860
1800

FIG. 18

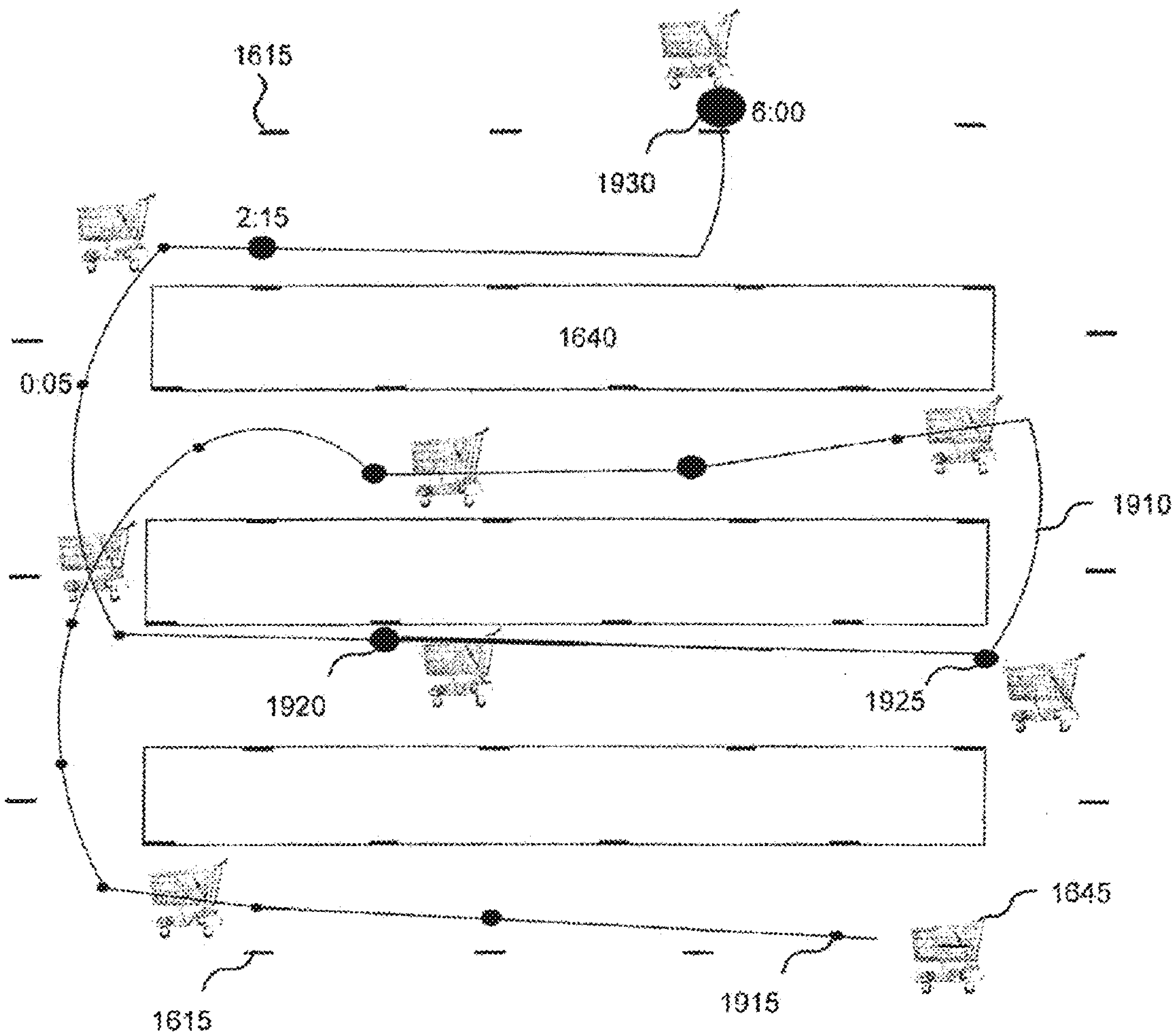



FIG. 19

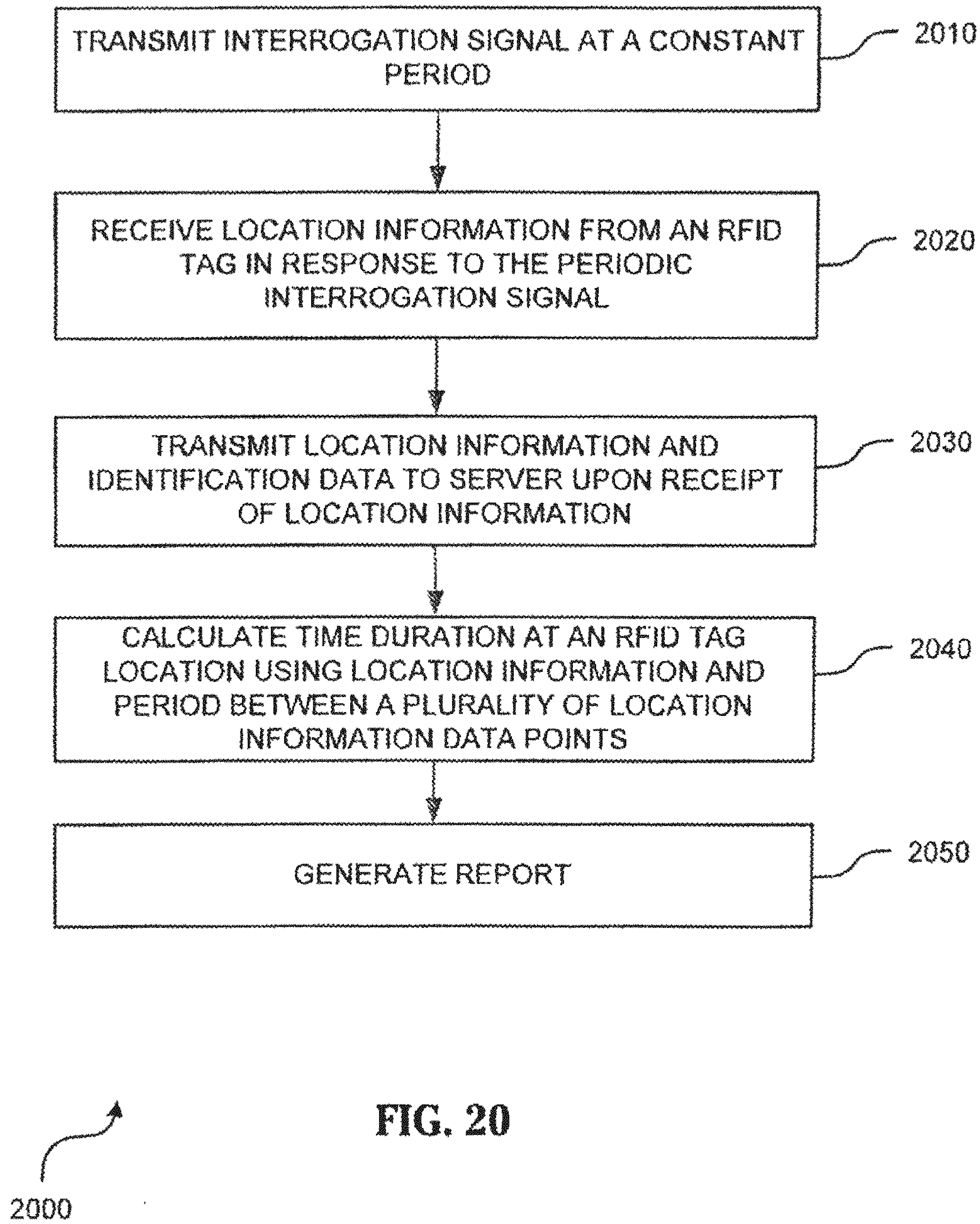

TRANSMIT INTERROGATION SIGNAL AT A CONSTANT PERIOD
2010
RECEIVE LOCATION INFORMATION FROM AN RFID TAG IN RESPONSE TO THE PERIODIC INTERROGATION SIGNAL
2020
TRANSMIT LOCATION INFORMATION AND IDENTIFICATION DATA TO SERVER UPON RECEIPT OF LOCATION INFORMATION
2030
CALCULATE TIME DURATION AT AN RFID TAG LOCATION USING LOCATION INFORMATION AND PERIOD BETWEEN A PLURALITY OF LOCATION INFORMATION DATA POINTS
2040
GENERATE REPORT
2050
2000

FIG. 20

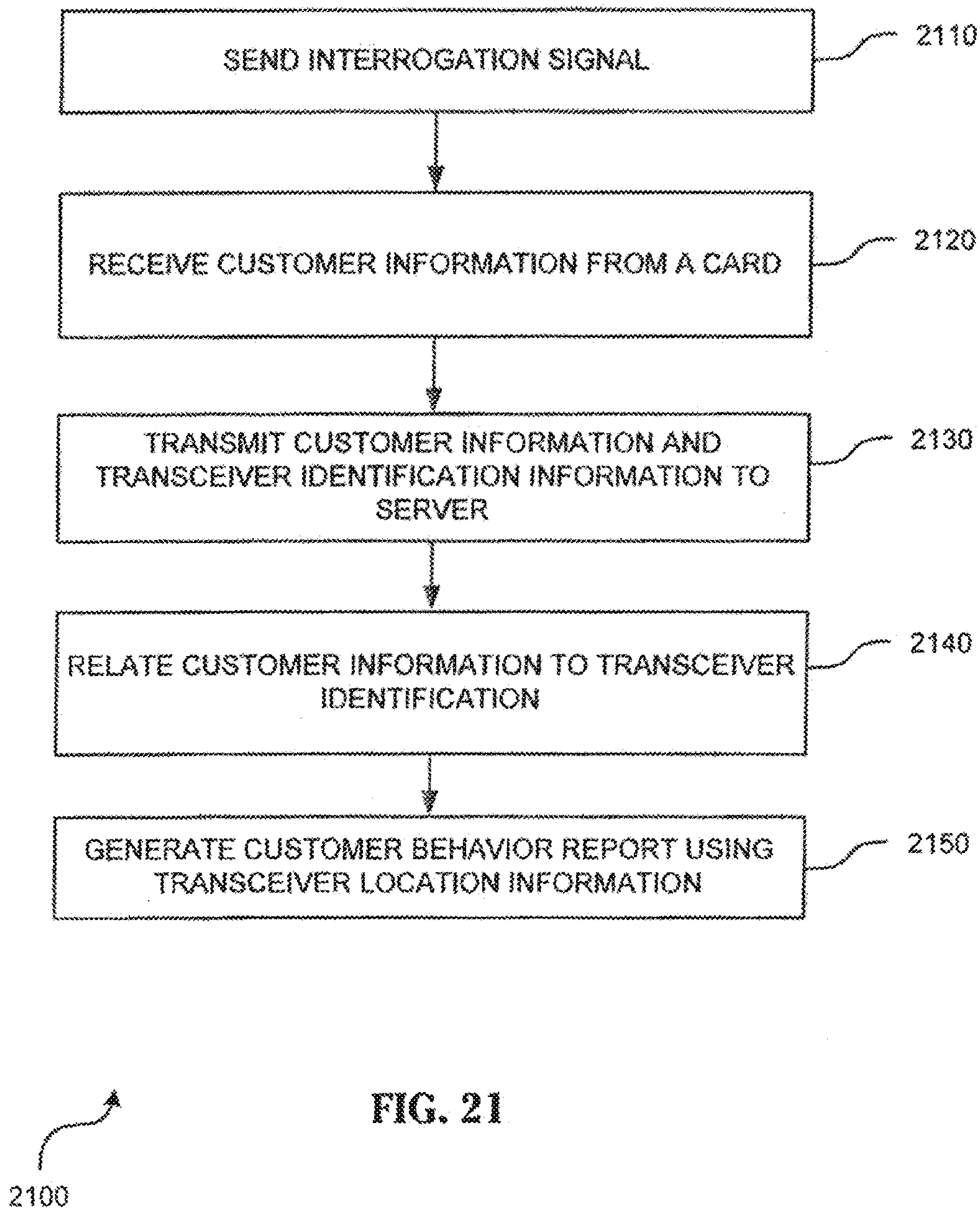

SEND INTERROGATION SIGNAL
2110
RECEIVE CUSTOMER INFORMATION FROM A CARD
2120
TRANSMIT CUSTOMER INFORMATION AND TRANSCEIVER IDENTIFICATION INFORMATION TO SERVER
2130
RELATE CUSTOMER INFORMATION TO TRANSCEIVER IDENTIFICATION
2140
GENERATE CUSTOMER BEHAVIOR REPORT USING TRANSCEIVER LOCATION INFORMATION
2150
2100

FIG. 21

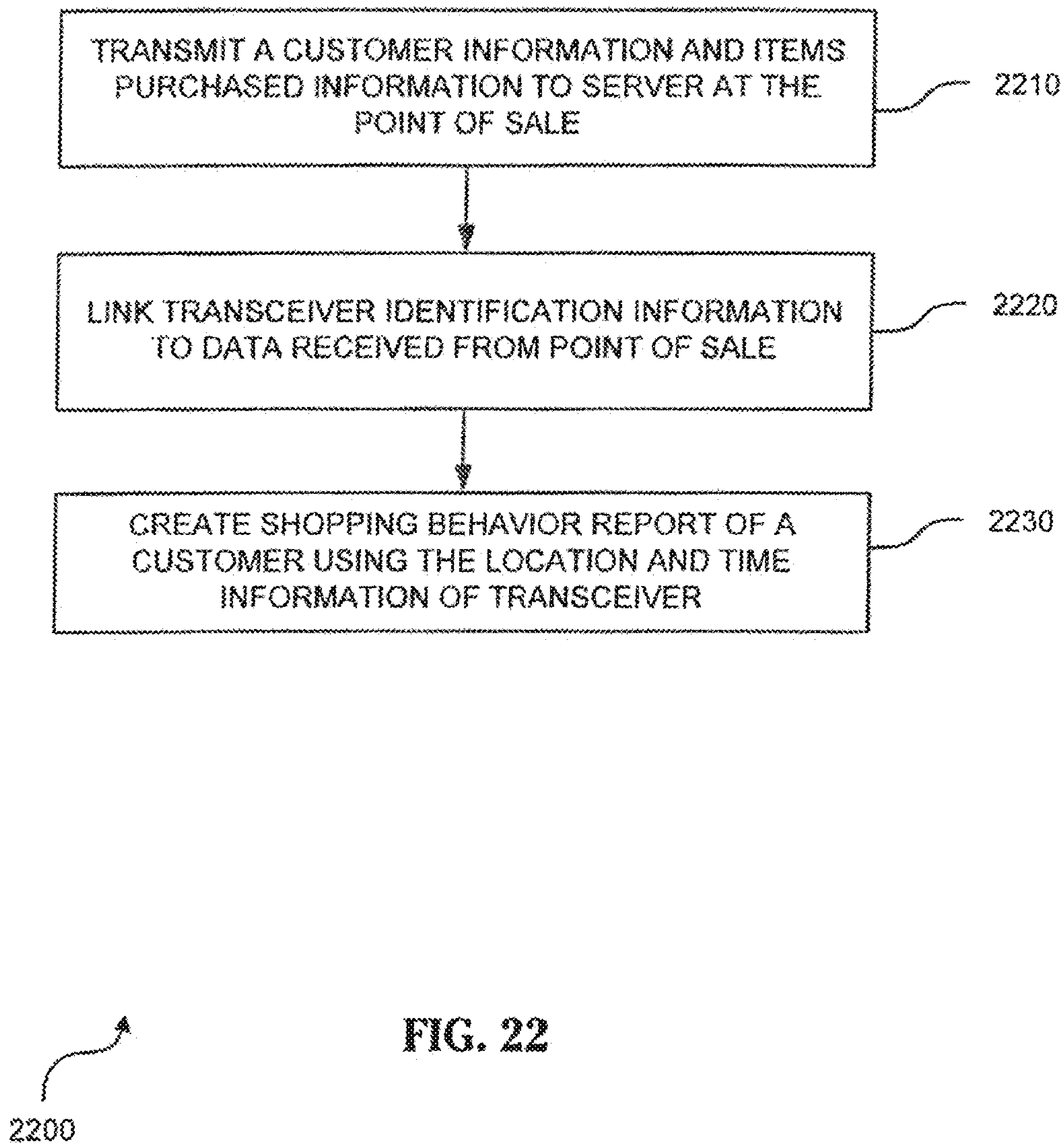

TRANSMIT A CUSTOMER INFORMATION AND ITEMS PURCHASED INFORMATION TO SERVER AT THE POINT OF SALE
2210
LINK TRANSCEIVER IDENTIFICATION INFORMATION TO DATA RECEIVED FROM POINT OF SALE
2220
CREATE SHOPPING BEHAVIOR REPORT OF A CUSTOMER USING THE LOCATION AND TIME INFORMATION OF TRANSCEIVER
2230
2200

FIG. 22

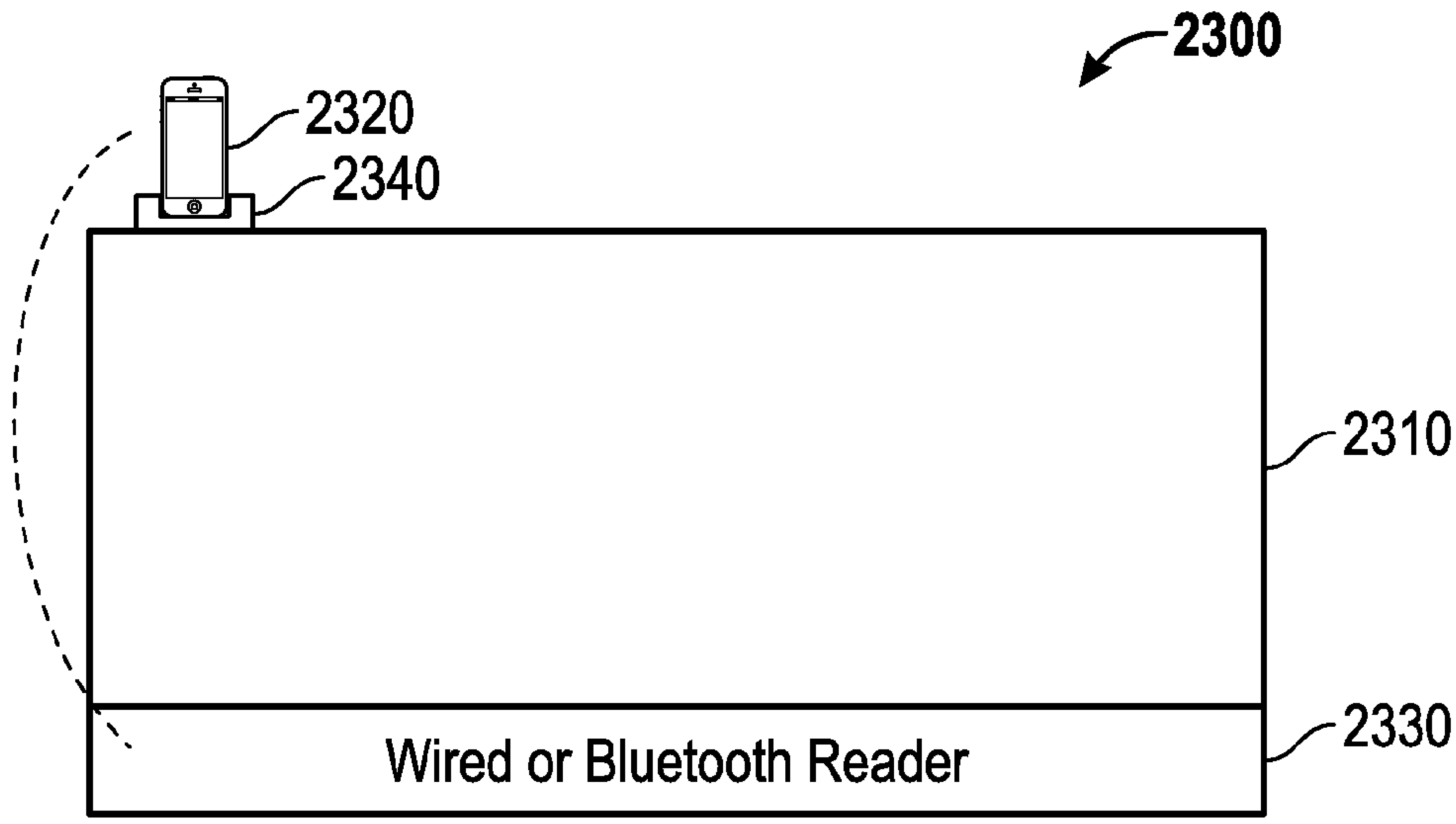



FIG. 23A

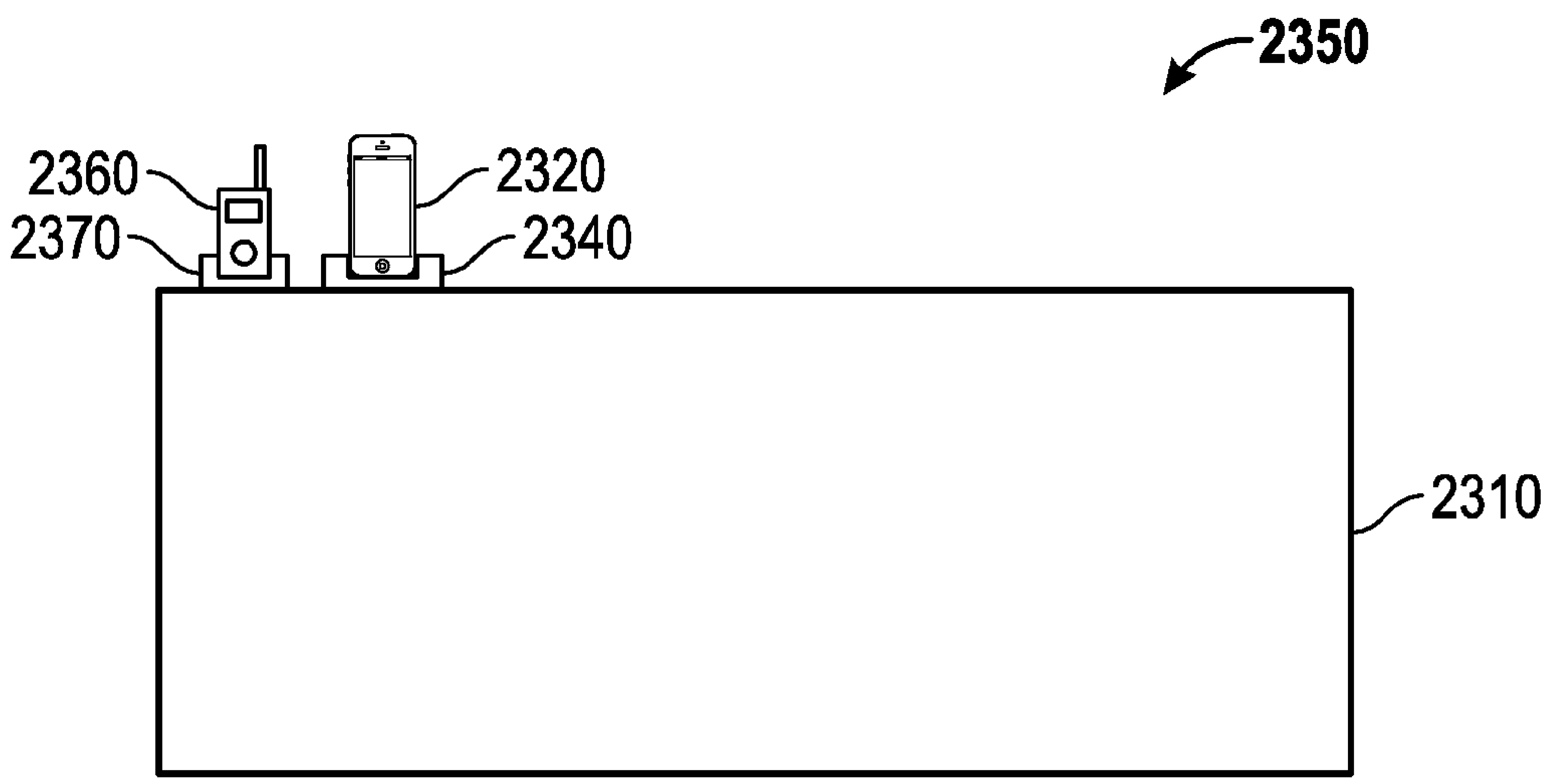



FIG. 23B

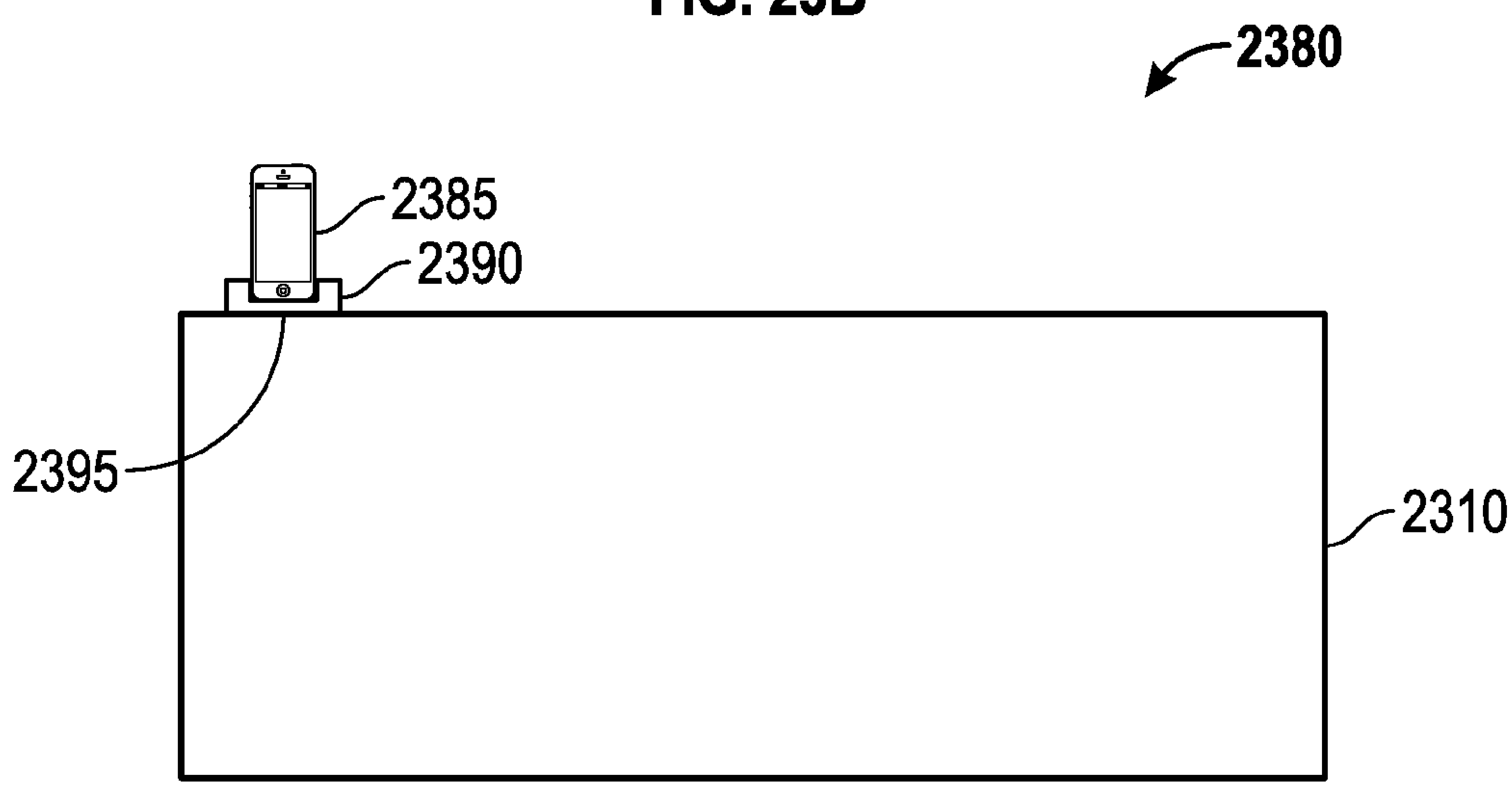



FIG. 23C

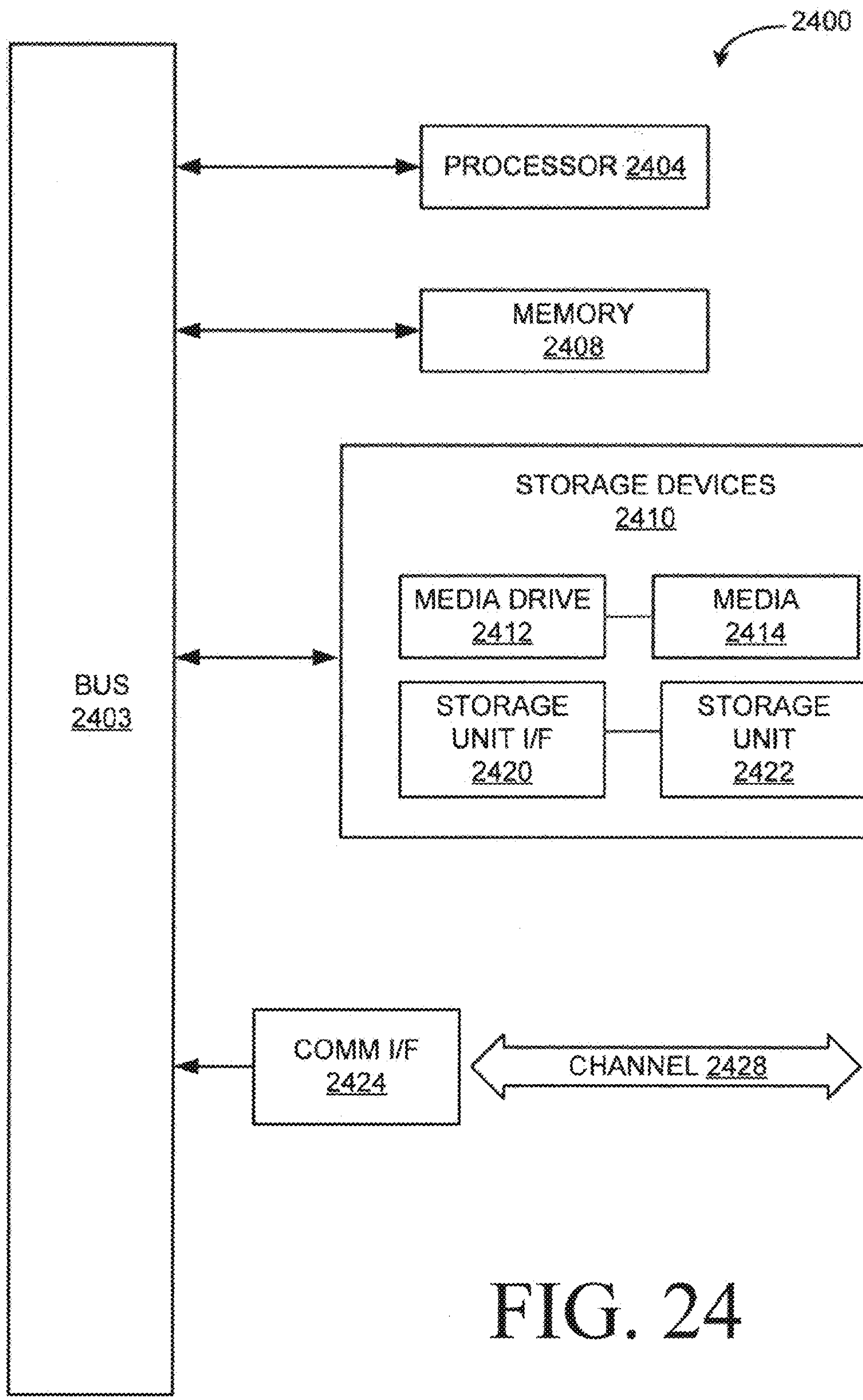

2400
PROCESSOR 2404
MEMORY 2408
STORAGE DEVICES 2410
MEDIA DRIVE 2412
MEDIA 2414
STORAGE UNIT I/F 2420
STORAGE UNIT 2422
BUS 2403
COMM I/F 2424
CHANNEL 2428

FIG. 24

# SYSTEM AND METHOD FOR TRACKING SHOPPING BEHAVIOR

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 13/479,723, filed May 24, 2012, which is a continuation of U.S. patent application Ser. No. 11/853,223, filed Sep. 11, 2007, now U.S. Pat. No. 8,207,851, issued Jun. 26, 2012, which is a continuation-in-part of U.S. patent application Ser. No. 11/782,402, filed Jul. 24, 2007, now U.S. Pat. No. 8,138,919, issued Mar. 20, 2012, which is a continuation-in-part of U.S. patent application Ser. No. 11/683,903, filed Mar. 8, 2007, now U.S. Pat. No. 7,772,976, issued Aug. 10, 2010, which is (i) a continuation-in-part of U.S. patent application Ser. No. 11/505,616, filed Aug. 16, 2006, now U.S. Pat. No. 7,683,782, issued Mar. 23, 2010, and (ii) a continuation-in-part of U.S. patent application Ser. No. 11/506,179, filed Aug. 16, 2006, now U.S. Pat. No. 7,728,729, issued Jun. 1, 2010, all of which are incorporated herein by reference in their entirety.

## FIELD OF THE INVENTION

The present invention relates generally to systems and methods for tracking shopping behavior, more particularly, to systems and methods for tracking traffic pattern in a store or other venue.

## BACKGROUND OF THE INVENTION

Targeted advertisement is an effective strategy for selling products. Most advertisements on television are played in shows having viewers within a certain age group. For example, advertisements for toys are usually placed in children oriented programming such as early morning and after school cartoons. Similarly, advertisements for automobiles, for example, are usually placed in adult oriented programming such as news and talk shows.

Billboard advertisement also applies a targeted advertisement strategy. Cites for billboard advertisements are generally selected based on the traffic and the demographic of the travelers making up the traffic. In this way, the message of the advertisement is directed toward a desired audience.

Similarly, the same marketing strategies apply for the placement of products in a store such as, for example, a grocery store, a department store, and an electronic store. Product placement in a store can be a key factor in the sale of the product. A product placed in a high traffic area will most likely garner more attention from shoppers and thus will produce more sales than a product placed in a low traffic area.

## SUMMARY OF THE INVENTION

According to various embodiments of the invention, systems and methods for tracking shopping behavior is provided. In accordance with one embodiment of the invention, the method comprises: emitting an RF interrogation signal using an interrogator relay unit ("IRU"); receiving, at the IRU, location data from an RFID tag in response to the RF interrogation signal; transmitting the location data, identification information of the IRU, and timestamp data to a remote server using the IRU; and generating a behavior report using the transmitted location data, the identification information, and the timestamp data. In one embodiment, the location data received from the RFID tag comprises information concerning where the RFID tag is located with respect to a reference point.

In one embodiment, the behavior report comprises a travel pattern of the IRU with respect to the reference point. The behavior report can be generated using location data from a plurality of RFID tags.

In another embodiment, the method calculates a time duration of the IRU being within a transmission range of the RFID tag by analyzing the timestamp data associated to the IRU identification information.

In yet another embodiment, RFID tag is a passive RFID tag. In still another embodiment, the plurality of RFID tags are located in a store. In one embodiment, the location data comprises location information of where the RFID tag is located within the store.

In still another embodiment, the IRU is located on a mobile container used for storing shopping materials.

In a further embodiment, the method comprises: transmitting the identification information of the IRU to a point-of-sale device; and transmitting purchaser information and items purchased information to the remote server once a sale transaction is completed using the point-of-sale device.

In yet another embodiment according the present invention, a method for tracking an interrogator relay unit (IRU) comprises: emitting RF interrogation signals at a prescribed interval using the IRU; receiving, at the IRU, location data from a plurality of RFID tags in response to the periodic RF interrogation signals; transmitting each of the received location data and identification information of the IRU to a remote server using the IRU; calculating time duration information of the IRU being within a transmission range of a first RFID tag using the prescribed interval and a number of times the location data from the first RFID tag is being transmitted along with the identification information of the IRU.

In yet another embodiment according the present invention, a system for tracking shopping behavior is provided. The system comprises: a plurality of RFID tags distributed within a structure, each RFID tag configured to contain location information regarding its position within the structure; a interrogator relay unit (IRU) configured to receive the location information from the plurality of RFID tags in response to interrogation signals transmitted by the IRU, wherein the IRU is configured to transmit the location information and an identification information of the IRU to a remote database; and a report generator configured to query the remote database and to generate a behavior report that comprises a travel pattern of the IRU with respect to the plurality of RFID tags. In the system, the remote database is configured to store and timestamp the location information received.

Other features and advantages of the present invention should become apparent from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The summary is not intended to limit the scope of the invention, which is defined solely by the claims attached hereto.

## BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described, by way of example only, with reference to the following drawings, in which:

FIG. **1** is a notional illustration of an example RFID system for locating an entity within a structure, in accordance with the principles of the present invention;

FIG. 2A is a schematic diagram illustrating an exemplary implementation of the RFID tags of FIG. 1 within a six-story structure;

FIG. 2B is a diagram illustrating the placement of RFID tags in a standard format within a building material;

FIG. 2C, is a diagram illustrating the placement of RFID tags in a standard format within a substantially linear building component;

FIG. 3 is a schematic diagram illustrating the progression of a fire fighter through the structure passing RFID tags while wearing a portable RFID transmitter/receiver (also herein referred to an interrogator relay unit ("IRU"));

FIG. 4 illustrates a notional base unit log that details the fire fighter's location within the structure over time as the fire fighter moves through the structure;

FIG. 5 is a detailed sectional view of the 4$^{th}$ floor of the structure illustrating the movement of the fire fighter through the structure;

FIG. 6 is a flowchart illustrating an example method for standardizing RFID function and location for the RFID system, in accordance with the principles of the present invention;

FIG. 7 is a flowchart illustrating an example method for data transmission from a passive tag to the RFID transmitter/receiver and to the base unit, in accordance with the principles of the present invention;

FIG. 8 is a flowchart illustrating an example method for downloading building data from an active RFID tag to the base unit computer, in accordance with the principles of the present invention;

FIG. 9 is an exemplary block diagram illustrating the major components and radio wave communication between the components of the RFID system of the invention;

FIG. 10 is an exemplary process flow diagram illustrating process communication within the RFID system of the invention;

FIG. 11 is a diagram illustrating the systems and methods described herein from a service view perspective and a display view perspective according to embodiments of the present invention;

FIG. 12 is a diagram illustrating an exemplary embodiment of the entity location system in accordance with the service view perspective and the display view perspective of FIG. 11 according to embodiments of the present invention;

FIG. 13A is a diagram illustrating an exemplary environment in which the invention may be implemented according to one embodiment of the present invention;

FIG. 13B illustrates a system including RFID tags containing precise location data placed throughout a warehouse;

FIGS. 14-15 illustrate exemplary process flows for transferring location-based data between a mobile device and a computer system according to embodiments of the present invention;

FIG. 16 is a diagram illustrating an exemplary environment in which a shopping behavior tracking system may be implemented according to one embodiment of the present invention;

FIGS. 17-18 illustrate exemplary process flows for tracking shopping behavior according to embodiments of the present invention;

FIG. 19 is a diagram illustrating an exemplary environment in which a shopping behavior tracking system may be implemented according to one embodiment of the present invention;

FIGS. 20-22 illustrate exemplary process flows for tracking shopping behavior according to embodiments of the present invention;

FIGS. 23A-23C illustrate several intelligent shopping unit configurations according to three embodiments of the invention.

FIG. 24 illustrates an example computing module that may be used in implementing various features of embodiments of the systems and methods described herein.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the invention in detail, it is useful to describe an example environment in which the invention may be implemented.

In the following paragraphs, the present invention will be described in detail by way of example with reference to the attached drawings. Throughout this description, the preferred embodiment and examples shown should be considered as exemplars, rather than as limitations on the present invention. As used herein, the "present invention" refers to any one of the embodiments of the invention described herein, and any equivalents. Furthermore, reference to various feature(s) of the "present invention" throughout this document does not mean that all claimed embodiments or methods must include the referenced feature(s).

The present invention is directed to systems and methods for obtaining location-based data on a mobile device. The method may comprise receiving location data from an RFID tag using the mobile device, transmitting identification data of the mobile device and the location data to a remote system, receiving customized data from the remote system, wherein the customized data are based on the location data from the RFID tag and the device ID, and presenting the customized data on the mobile device.

By way of example, the entity may comprise a person or an item that is located within a structure such as a building, a subway, or a mine. More particularly, the entity is fitted with a portable RFID transmitter/receiver, and the structure is provided with a plurality of RFID tags. Each RFID tag may comprise a passive or active device that transmits its location to the transmitter/receiver. The transmitter/receiver then transmits the location of the entity to a base unit computer, which displays the location of the entity. In this manner, the RFID system of the invention may continuously monitor the location of any entity that is fitted with a transmitter/receiver. By continuously monitoring the location of an entity that is fitted with a transmitter/receiver, the entity may be tracked. This tracking may occur almost any time two or more locations for the same entity are determined.

In conventional systems, an RFID tag is attached to the entity such that the tag may move past a stationary RFID receiver, referred to as an "interrogator", and the system records the information from the tag. There are several proposals for use of RFID technology in buildings or for emergency personnel. Such stationary systems require installation of RFID interrogators throughout buildings to accurately track personnel locations, which may be incredibly expensive and impractical, particularly when considering that the interrogators are far more expensive than the RFID tags. In addition, the interrogators require emergency backup power when there is a loss of power to the building. In the RFID system of the present invention, the process is reversed so that a plurality of stationary RFID tags are positioned at predetermined locations throughout structures such as buildings and subways, wherein each stationary tag identifies the location of an entity within the structure. In view of the high relative cost of the conventional stationary RFID receivers, placing RFID tags throughout the building and only requiring a limited number of emergency personnel to wear an RF transmitter/receiver will result in an enormous cost savings, particularly for large structures.

Referring to FIG. **1**, in accordance with the principles of the invention, an RFID system **100** for locating an entity within a structure comprises one or more portable radio frequency (RF) transmitter/receiver units **110**, a base unit **120** providing a command and control function, and a plurality of passive RFID tags **130**. According to other embodiments described herein, active RFID tags **130** may be employed. The base unit **120** may comprise a computer including a processor, a memory, an operating system, a database, an HMI, and an RF receiver. The RF receiver may comprise a PC card on the motherboard or a PCMCI card or with a USB interface, including interface software comprising machine readable instructions for allowing communication between the RF transmitter/receiver **110** and the base unit receiver, and then unpacking the data transmissions and load records to a database (not depicted). In one embodiment the portable RF transmitter/receiver unit **110** is battery-operated, wherein the battery life is sufficient for the duration of an operation.

According to the invention, the RF transmitter/receiver **110** may read an RFID tag **130** and thereby determine location based on the known location of the RFID tag **130**. The location of RFID tag **130** may be determined by location data embedded in RFID tag **130**. The embedded location data may be programmed into RFID tag **130** using clear text or other suitable languages. The location data may include the floor number and location within the floor, latitude, longitude, elevation, and/or other location information. In a preferred implementation, the RF transmitter/receiver **110** may determine location information using other location determination systems and methods. For example, in the preferred embodiment of the invention, the RF transmitter/receiver **110** is capable of reading an RFID tag **130** and receiving GPS signals from GPS satellites. Generally, RFID tags **130** are used to track entities within buildings, underground, etc., while GPS is employed to determine location outside. It will be understood, however, that in certain cases GPS signals may be receivable inside (e.g., near a window), and in other cases RFID tags may be employed to determine location outside (e.g., RFID tags **130** may be attached to the exterior of buildings). Such a system may be useful in extremely dense urban areas where GPS signals may be blocked by tall buildings or interfered with by other electromagnetic signals.

Since the RFID system **100** of the invention broadcasts location data in real time, the location of the person (or entity) is recorded at the base unit **120**. Using the location data, rescue personnel may be immediately directed to the real time location of the entity within a structure, and the man-portable unit does not need to continually function as a beacon. By way of example, the structure may comprise a building, subway or mine. One of ordinary skill in the art will appreciate that the RFID system **100** may be employed to locate entities within various other structures without departing from the scope of the invention.

While the supplemental location determination device will generally be GPS, other location determination systems may also be used. Further, the supplemental location determination system may be augmented by, for example, Local Area Augmentation System (LAAS), Wide Area Augmentation System (WAAS), Differential GPS (DGPS), etc. Additionally, as used herein GPS refers to the Global Navigation Satellite System (GNSS) developed by the United States Department of Defense, (NAVSTAR GPS) and any other similar GNSS, for example, Galileo, GLONASS, etc. Additionally, while the supplemental location determination system is referred to as "supplemental" it will be understood that, in some cases, it may provide location information more frequently than the RFID entity location system. Such cases include instances wherein the entity to be tracked spends more time in areas where GPS signals may be received than in areas where RFID tag signals may be received.

FIG. **2A** illustrates a schematic view showing the implementation of the RFID system **100** of the invention within a six-story structure **150**. Specifically, the RFID system **100** comprises a plurality of passive RFID tags **130** disposed at predetermined intervals within the six-story structure **150**. In the illustrated embodiment, the passive RFID tags **130** are separated by intervals of approximately fifty feet. Additional tags **130** may be provided at other locations within the structure **150**, for example at entrances, exits, stairwells, particular rooms, or every room in the structure **150**. According to the invention, a standard may be developed to determine an appropriate or optimum distance between passive tags **130** for a particular structure. According to one implementation of the invention, the RFID tags **130** are passive devices such that they do not require AC or DC power, and each tag **130** has an RF signal containing unique location information. In operation, an RF transmitter/receiver (attached to an entity within the structure **150**) sends a signal to an RF tag **130** and then records the RF backscatter signal of the tag **130**. The RF signal of the tag **130** may include unique location information. As set forth above, the RFID system **100** has many additional useful applications such as with respect to mining operations, hospitals, in underground parking garages, and other business where one needs to quickly locate people or assets, particularly during an emergency situation.

According to a further embodiment of the invention, active RFID tags **130** may be employed within the RFID system **100**. In this embodiment, the base computer **120** emits an RF interrogation signal at predetermined, constant, rapid intervals. Once the base computer **120** enters the effective range of an active RFID tag **130**, the active tag **130** receives the request and transmits radio waves including signals representing building data, such as the address of the building, contact information, and/or a schematic of the building. Upon receiving the building data, the base unit computer **120** stores the building data, and displays the building data on a human-machine interface ("HMI") such as a graphical user interface ("GUI"). Unlike the passive tags, the active tags of this embodiment require an AC or DC power source.

In one embodiment RFID tags may be placed within building materials. In another embodiment RFID tags may be attached to building materials during the manufacture of these materials. In yet another embodiment RFID tags may be attached during the construction of a building. In this way RFID tags may be propositioned in or on building materials to expedite the installation of tags within buildings. For example, building materials that may contain tags include drywall or sheetrock, baseboards, wallpaper, fabric, plywood, concrete, stucco, or plaster. In another embodiment tags may also be placed within pre-manufactured walls and/or modular furniture during the manufacture of these items.

According to various embodiments, RFID tags **130** are integrated into one or more building materials at the manufacturing plant such that they are contained within such building materials. Alternatively, RFID tags **130** may be attached or affixed to the building materials in any conventional manner such as via fasteners or using an adhesive. RFID tags **130** may also be attached or integrated into building materials on site after material installation. Any of the RFID tags **130** can be pre-programmed with unique information at the manufacturing plant, or can be programmed or reprogrammed onsite after manufacturing or installation. Any of the building materials described herein can contain any number of RFID tags **130** integrated into the building materials, or can have any number of RFID tags **130** attached or affixed thereto.

In some embodiments, RFID tags **130** are disposed at predetermined intervals within building materials of a structure. As illustrated in FIG. **2**B, the tags **130** can be placed in a standard format within the building materials such as in 12"×12" squares of a wall material (i.e., the tags **130** are disposed 12" apart within a substantially planar surface **135** such as a wall, floor, ceiling or door). As illustrated in FIG. **2**C, the tags **130** can be placed in another standard format such as at every 6"-12" feet of a substantially linear building component **145** such as a pipe or a cable. In further embodiments, RFID tags **130** may be disposed at intervals that are not predetermined. Further, the RFID tags **130** do not have to be placed at a particular interval within a building material. Additionally, the distance between RFID tags **130** does not have to be predetermined or constant. The locations may be determined after the RFID tags **130** have been placed or the building materials added to the structure.

Generally, the more accurately the location of an RFID tag **130** is known, the more precisely an entity may be located. As the range of the RFID reader on the entity increases, the accuracy may decrease because the RFID reader may determine that the entity is located at a tag that is actually some distance away from the tag. In some embodiments of the invention, accuracy may be improved by the addition of more RFID tags **130** within the building materials.

Various categories of building materials that can be embedded with RFID tags **130** (or to which RFID tags **130** can be attached) include, but are not limited to: wall materials, rough building materials, flooring materials, ceiling materials, doors, and other building materials. Wall materials can include without limitation: drywall (wallboard), wood paneling, acoustical wall panels, baseboard, traditional wall covering, fake stones, and structural insulated panels. Rough building materials may include without limitations: wood studs, metal studs, brick, concrete, plumbing pipe, fire sprinkler pipe, wiring, conduits and piping. Flooring materials can include without limitation: tiles (ceramic, vinyl, stone, etc.), wood laminate, solid wood, bamboo, carpet, rugs, cork and sheet vinyl. Ceiling materials may include without limitation: acoustic tile, drywall, metal ceiling grid, acoustical panels, lighting fixtures, fire sprinklers, HVAC grills (diffusers), and HVAC ducting. With regard to doors, RFID tags **130** can be placed, for example, within door jambs, door knobs, etc. Further examples of building materials that can be embedded with RFID tags **130** (or to which RFID tags **130** can be attached) include thermostats, utility outlets, cover plates, windows and glass, chair rails, wall and corner guards, and hand rails.

FIG. **3** is a schematic view that depicts the progression of a fire fighter **170** past the RFID tags **130**, wherein the fire fighter **170** is wearing a portable RFID transmitter/receiver unit **110**. As the fire fighter **170** walks past an RFID tag **130**, the RF transmitter/receiver **110** records the location of the tag **130** and broadcasts the location of the tag **130** (and the fire fighter **170**) to the base unit computer **120**, which maintains a log of the current location of each RF transmitter/receiver **110** on an on-going basis. Locations are updated every time an RF transmitter/receiver **110** passes an RF tag **130** at constant, predetermined and rapid intervals. Alternatively, locations are updated when an RF transmitter/receiver **110** passes a predetermined number of RF tags **130**, or at a predetermined time interval. As such, the base unit **120** records the location of each entity (or fire fighter) that is accurate to the distance between RFID tags **130**. In FIG. **3**, the fire fighter **170** is illustrated as moving past RF tags **130** on the fourth floor of the structure **150** of FIG. **2**. In the first frame, the fire fighter **170** passes the RFID tag **130**A positioned at 50 feet from the left wall on the fourth floor of the structure. In the second frame, the fire fighter **170** walks past the tag **130**B at 100 feet from the left wall. In the third frame, the fire fighter **170** passes the RFID tag **130**C located 150 feet from the left wall. As the fire fighter **170** passes each RF tag **130**, his personal RFID transmitter/receiver **110** records its location and forward the location to the base unit **120**, which track the location in a log.

FIG. **4** illustrates a base unit log **190** that details the fire fighter's location within the structure **150** over time as the fire fighter **170** moves through the structure **150**. Particularly, the initial entry in the base unit log **190** was recorded as the fire fighter **170** entered the structure **150**, passing an RFID tag **130** at the entrance. According to the invention, this particular entrance tag **130** may contain general information about the building such as address, the building's contact information, the building owner's contact information, the number of floors, and/or a schematic of the building. In the illustrated embodiment, the base log **190** contains information pertaining to the identification of the fire fighter **170**, the contact information of the structure **150**, the address of the company or companies residing in the structure **150**, the entity's position and time for each log entry, and the current date. The base unit log **190** then recorded the fire fighter's locations in real time as he or she traveled to the fourth floor via the stairwell, passing several more tags **130**. The fire fighter **170** then exited the stairwell on the fourth floor, and the three highlighted entries in the base unit log **190** coincide with the movement of the fire fighter **170** illustrated in FIG. **3**.

According to the invention, it is anticipated that the efficacy of the RFID system **100** will dramatically increase if an entire metropolitan area adopts a set of standards and associated regulations, for example, to require the installation of RF tags in all multi-story buildings, subways, and in all mines. In one embodiment, if all building owners were required to install RFID tags in a uniform manner, emergency personnel would be assured of consistency from building to building and accuracy of the location data at each specific building. By way of example, a standard for the spacing between tags may be adopted to ensure consistent data from building to building. Greater resolution may be realized by reducing the distance between RFID tags.

FIG. **5** illustrates a detailed sectional view of the 4$^{th}$ floor of the structure **150** for identifying and displaying the movement of specific personnel (e.g., the fire fighter **170**) as they move through the structure **150**. With the adoption of an entrance RFID tag **130**, emergency personnel may download a schematic of the structure **150** to the base unit **120** to display a "bird's-eye" view or other views of any floor or multiple floors of the structure **150** and the position of any fire fighter **170** within the structure. The schematic is updated to show the movement of the fire fighter **170** every time he or she passes an RFID tag **130**. In the illustrated embodiment, emergency personnel No. 5 (fire fighter **170**) has recently moved from the stairwell on the 4$^{th}$ floor (RFID tag **130**D), past RFID tag **130**E, and is currently positioned near RFID tag **130**E.

The RFID system of the invention may be implemented utilizing Commercial, Off-The-Shelf ("COTS") technology currently manufactured and sold by various companies. In particular, RFID tags and personal computers are readily available at any number of global suppliers. The base unit of the RFID system may further require a database for storing and retrieving information as well as a graphic user interface ("GUI") for displaying the retrieved information. RFID interrogators that collect the data from an RFID tag and transmit the data via cable to a computer for processing are currently available. Additionally, manufacturers currently produce hand-held interrogators that collect data, and then download the data at a later time when the interrogator is placed in a cradle connected to a computer. For the RFID system set forth herein, a new type of portable interrogator is necessary that is capable of transmitting the recorded data to the base unit in real time. In one embodiment the unit is battery-operated, portable, as light weight as possible, and protected from the elements.

Referring to FIG. **6**, a method **200** for standardizing RFID function and location for the RFID system of the invention will now be described. Initially, step **210** involves creating a standard for the data content and optimum placement of passive RFID tags **130** within a structure. At a minimum, the standard should address the data to be stored on the tag **130**, the mounting location of the tag **130** and the distance between tags **130**. Step **220** involves creating a standard for identifying the RFID transmitter/receiver unit **110** and the entity (or person) on which the unit **110** is fitted. This step may involve programming each RFID transmitter/receiver unit **110** to identify the individual, asset or entity to which it will be attached. Subsequently, step **230** involves mounting a plurality of RFID tags **130** on surfaces of the structure in accordance with the standard and programming each RFID tag **130** in accordance with the standard (i.e., using an RFID transmitter/receiver unit **110** to program the location data into the tags **130**). According to some embodiments of the invention, the method may further entail the steps of: (1) mandating the use of RFID tags in all structures of a particular municipality (step **240**); and/or (2) creating a standard for the data content and optimum placement of an RFID tag **130** at the entrance of a structure (step **250**). This standard addresses the mounting location and the data to be stored on the tag, including the address, contact information, and a building schematic.

Referring to FIG. **7**, a method **300** for data transmission from a passive tag **130** to an RFID transmitter/receiver unit **110** and to the base unit computer **120** will now be described. In step **310**, the base unit computer **120** (which may be located inside or outside of the structure) is turned on and an entity (or person) is fitted with a portable RFID transmitter/receiver unit **110**. In step **320**, the portable RFID transmitter/receiver unit **110** emits an RF interrogation signal at constant, predetermined and rapid intervals. Step **330** involves the entity entering the structure fitted with passive RFID tags **130** and moving within the effective range of a stationary RFID tag **130**. Upon receipt of the RF energy by the RFID tag **130**, the method **300** proceed to step **340**, wherein the passive tag **130** powers up and emits a signal **345** (or a series of signals) containing the location data, which may include, e.g., the floor number and location within the floor, latitude, longitude, and elevation, or other location information, such as a tag serial number that may be mapped to a location. For example, in one embodiment information about location based on tag serial number may be stored in a database. When a tag serial number is received this location information may be looked up in the database.

This may occur, for example, at an interrogator, at a base unit, or where ever the tag serial number is received and a copy of the data base is available. The tag number may be received by a device that contains the database either directly from an RFID tag or it may be transmitted from another device. For example an interrogator may transmit an RFID tag serial number to a base unit that includes a copy of the database. In step **350**, the RFID transmitter/receiver unit **110** receives the location data from the passive tag **130**, and transmits the location data and its unit ID to the base unit **120**. In step **360**, the base unit computer **120** receives the location data and unit ID, stores this information with the time, and displays all of the data on the HMI.

Referring to FIG. **8**, a method **400** for downloading building data from an active RFID tag **130** to a base unit computer **120** having a system transmitter/receiver will now be described. Step **410** involves powering on the portable base unit **120**. In step **420**, the base computer **120** begins to emit an RF interrogation signal at predetermined, constant, rapid intervals. Once the base computer **120** enters the effective range of the active RFID tag **130**, the method proceed to step **430**, wherein the active tag **130** receives the signal and powers on. In step **440**, the active RFID tag **130** transmits building data in the form of a signal **445** (or a series of signals). For example, the building data may include without limitation, the address of the building, contact information, and a schematic of the building. In step **450**, the base unit computer **120** receives the building data, stores the building data, and displays the building data on the GUI.

FIG. **9** is an exemplary block diagram **500** of the major components illustrating radio wave communication between the components of the RFID system **100**, including RFID tags **130**, RFID transmitter/receiver **110** and base unit computer **120**. The portable RFID transmitter/receiver **110** comprises a processor **510**, a power cell **520**, interrogator communications **530** for interrogating the RFID tags **130**, and base unit communications **540** for sending data to the base unit computer **120**. The base unit **120** comprises a portable computer including at least one database **550**, an HMI **560**, and RFID transmitter receiver communications **570** for receiving data from the portable RFID transmitter/receiver **110**. As would be understood by those of ordinary skill in the art, many additional system configurations are possible without departing from the scope of the invention.

FIG. **10** is an exemplary process flow diagram **600** illustrating process communication within the RFID system **100** of the invention. In particular, the RFID transmitter/receiver **110** interrogates an RFID tag **130** (process **610**), and, in response, the RFID tag **130** sends its location and RFID tag unit identification to the RFID transmitter/receiver **110** (process **620**). Upon receiving the location information (process **630**), the RFID transmitter/receiver **110** stores the location (process **640**) and sends the location and RFID tag unit identification to the base unit computer **120** (process **650**). The base unit **120** receives the location and RFID tag unit identification (process **660**), stores the location, RFID tag unit identification and the time of the data entry (process **670**), and displays the location, RFID tag unit identification and the time of the data entry (process **680**). Other process flow arrangements are possible without departing from the scope of the invention.

The present invention has been described above in terms of presently preferred embodiments so that an understanding of the invention may be conveyed. However, there are other embodiments not specifically described herein for which the invention is applicable. Therefore, the invention should not be seen as limited to the forms shown, which is to be considered illustrative rather than restrictive. For example, the systems and methods described herein have been described with respect to example embodiments wherein RFID tags **130** are disposed at predetermined intervals within a structure. As would be understood by those having ordinary skill in the art, in other embodiments, RFID tags **130** may be disposed at intervals that are not predetermined. Further, the RFID tags **130** do not have to be placed at a particular interval. Additionally, the distance between RFID tags **130** does not have to be predetermined or constant. The locations may be determined after the RFID tags **130** have been placed. The placement of one or more RFID tags **130** is all that is necessary. As long as the location of an RFID tag is known, an entity may be located if it is within the range of the particular RFID tag **130**.

Generally, the more accurately the location of an RFID tag **130** is known, the more precisely an entity may be located. As the range of the RFID reader on the entity increases, the accuracy may decrease because the RFID reader may determine that the entity is located at a tag that is actually some distance away from the tag. In some embodiments of the invention, accuracy may be improved by the addition of more RFID tags **130** such that the predetermined distance between RFID tags **130** is reduced. Accordingly, as would be understood by those of ordinary skill in the art, the "exact location" of an entity being located is subject to the accuracy limitations of the systems and methods described herein.

The present invention provides systems and methods for tracking entities (e.g., people, things), wherein the entities may be tracked as they move, both inside and outside of structures. The structures may be terrestrial (e.g., buildings) and subterranean (e.g., mines, subways). The location of entities that are not moving (e.g., at least temporarily still) may also be determined. Location, or tracking, data may be integrated with other relevant data, including without limitation, (i) ancillary tracking systems (e.g., GPS, acoustic homing), (ii) local environmental conditions, (iii) local infrastructure (e.g., electrical wiring, plumbing, (iv) hazardous material), (v) personal data (e.g., temperature, heart rate), and (vi) geospatial support data including maps, images and features (e.g., roads, bridges, railroads, communication lines). In some embodiments infrastructure data may include national, state, local, or tribal infrastructure data.

In one embodiment the data may be observed almost anywhere on Earth through connectivity with the internet or by wireless communication such as satellite, cellular, or other wireless communication systems, including combinations of multiple communication systems. Observers may use multiple methods for data presentation. For example, the collection of interior positioning system ("IPS"), exterior position system ("EPS"), or both, may be provided by a web based service which may be used by subscribers. In some embodiments, the location information may be used in conjunction with mapping services, for example Google Earth, Microsoft Virtual Earth, Google Maps, Yahoo Maps, or other mapping services. In another embodiment the mapping information may be integrated into the web based service.

It will be understood that IPS will generally refer to the positioning system for inside a structure, mine, parking garage, etc., (e.g., an RFID based system) while EPS will generally refer to the position system for outside, (e.g., GPS). These terms are not intended to be limiting, however. For example, an RFID system may be used outside (e.g., by attaching RFID tags to the outside of a building), and in some cases GPS me be able to be used inside, e.g., near windows, skylights, openings, etc.

The systems and methods described herein may be implemented in many different types of devices. For example, the system may incorporate use of presentation devices that may include SmartPhones, PDAs, laptops, personal computers and thin client browsers. Other presentation devices may include local display of data where presentation services are included in the Interrogator Relay Unit ("IRU") or Smart IRU.

Referring now to FIG. **11**, the systems and methods described herein will now be discussed from a service view perspective **700** and a display view perspective **702**. In particular, the service view **700** illustrates the architectural concepts, whereas the display view **702** illustrates operational concepts and potential implementations or embodiments. In other words, the service view **700** depicts various systems and methods described herein from the perspective of the services, while the display view **702** depicts various systems and methods described herein in terms of different example devices that may be employed. It will be understood that these are not the only devices that may be used to implement the systems and methods described herein. It will be further understood that the systems and methods described herein may, in some cases, be useful for providing services in addition to or in place of the example services discussed.

In the service view perspective **700**, the architecture may be broken down into data management **704**, collection **706**, dissemination **708**, and presentation **710**. Conceptually, these elements could be services in a service-oriented architecture ("SOA"), where functionality and data flow are orchestrated by workflow middleware. The display view **702** may include different implementations or embodiments of elements of the service view **700**. The spectrum of devices may range from a simple browser **712** to a smart IRU **714** that interrogates, relays location and other data to a base unit and also displays results locally to the host. In addition, the display view **702** may include a GIS **716** and/or a cell phone **718**. Data can be transmitted and received between various components **712**, **714**, **716**, and **718** and the services **700** using communication channel **720**.

FIG. **12** is a diagram illustrating an example embodiment of entity locating system **730**. FIG. **12** further illustrates the service view perspective **700** and the display view perspective **702** of FIG. **11**. The diagram includes examples of data management **704**, collection **706**, dissemination **708**, and presentation **710**. Data management **704** may include (i) data models, (ii) data collection or ingest, (iii) data storage, (iv) data logging (archiving), (v) data export, and (vi) data integration. Data models may define the entities and their relationships relevant to the systems and methods described herein. Data models may further provide a common vocabulary for integrating data from multiple sources.

FIG. **13**A illustrates yet another exemplary environment **1300** in which the invention can be implemented. Environment **1300** is a wireless network environment such as LAN, WAN, or other similar wireless network. Alternatively, environment **1300** may comprises a combination of a wireless network and a wired network. For example, a mobile device may be wirelessly connected to a network **1305**, and a ViewPoint **1320** may be directly connected to network **1305** via POTS or other suitable wired network. Environment **1300** can be in a urban setting, or other areas where GPS signals are not reliable. Alternatively, environment **1300** can be integrated with various data services such as GPS or web-based data services such as MSN Maps for example.

As shown, environment **1300** includes network **1305**, RFID tag **1310**, a computer system **1320**, a database **1330**, a server/database **1340**, a mobile telephone **1350**, and a mobile device (PDA) **1360**. In addition to other functionalities that will be described herein, environment **1300** incorporates all of the features of RFID system **100** as described above. Similarly, RFID tag **1310** incorporates all features previously described for RFID tag **130**.

In environment **1300**, RFID tag **1310** may be located in front of a building entrance such that a mobile device can be detected as it enters the building. Alternatively, RFID tag **1310** comprises a plurality of tags that are distributed throughout a building. Each of the tags contains data specific to its location in the building. For example, RFID tags **1310** can be placed at various departments of a store such as the shoes department, men's clothing, women clothing, and home furnishing, etc. RFID tags **1310** at the shoes department may contain location information for informing mobile device **1360** of its location in the store.

In one embodiment, mobile device **1350** or **1360** transmits its location information along with its identification data to computer system **1320**, also referred to as the ViewPoint system **1320**. This allows the ViewPoint system **1320** to know the approximate location of the customer (the user of mobile device **1360**) within the store. In this way, the ViewPoint system **1320** can notify the staff of the customer's presence in order to expedite service and to attend to the customer's needs. Additionally, the ViewPoint system **1320** may transmit information such as advertising materials related to shoes directly to the mobile device **1320** or to RFID tags **1310** located in the shoes department. In this embodiment, the ViewPoint system **1320** may communicate to RFID tags **1310** which, in turn, communicate to mobile devices **1350** or **1360**. In this way, the information stored in RFID tags **1310** can be dynamically customized for different customers.

Similar to RFID tags **130**, RFID tags **1310** may be disposed inside of a structure's building materials such as sheetrock, baseboard, ceiling and floor panels, window frames, and concrete, for example, during the construction of the structure. RFID tags **1310** can be purchased in bulk by the OEM of building materials, which places RFID tags **1310** into the building materials during the manufacturing process. These pre-disposed RFID tags **1310** may then be programmed or re-programmed at a later stage to hold data specific to their final destination.

As shown in FIG. **13**, the ViewPoint system **1320** is connected to database **1330**. The ViewPoint system **1320** is designed to interface with mobile device **1350** and PDA **1360** to collect device related data such as the device's present location, identification data and communications capabilities (802.11, Bluetooth, etc.). A mobile device can be identified by its device ID using 802.15 communications, or by the device's MAC address for 802.11 communications. The ViewPoint system **1320** stores data collected from mobile devices **1350-1360** into database **1330** with reference to the device identification data such as the device serial number or MAC address. In this way, data relating to a particular device may be easily retrieved in the future. The ViewPoint system **1320** may also store data in a remote database similar to database **1340**.

Database **1340** is a remote database that stores essentially the same data as database **1330**. However, since database **1340** is off-site and is directly connected to network **1305**, it can be configured to collect and store data from other RFID environments, GPS systems or other relevant sources, such as RFID system **100**. In this way, data relating to a particular mobile device can be shared between different RFID environments worldwide.

In environment **1300**, the ViewPoint system **1320** is designed to collect data from a plurality of mobile devices that are within the communication range of RFID tag **1310**. As an example of this functionality, once PDA **1360** is within the communication range of RFID tag **1310**, RFID tag **1310** will transmit its location data to PDA **1360**. This allows PDA **1360** to establish its location. As mentioned, location data may include the floor number and location within the floor, latitude, longitude, and elevation, or other location information, such as a serial number of RFID tag **1310** that may be mapped to a location. In one embodiment, the location data includes longitude data, latitude data, elevation data, and position data relative to a reference point such as an entrance of a structure, a section of a structure, or relative to compass headings (e.g., north, south, east, or west). The location of RFID tag **1310** may be stored in a database along with its serial number, for example. In this way, PDA **1360** may determine its location and send the location information received from RFID tag **1310** to the ViewPoint system **1320**. Once the ViewPoint system **1320** receives the location data from PDA **1360**, the ViewPoint system **1320** may look up the corresponding location data in database **1330**.

In a traditional environment, conventional RFID tags can be used to track the movement of assets (e.g., parts and components) into and out of a structure such as a warehouse utilizing choke points or close proximity readers. By contrast, system **1335** augments traditional RFID by tracking and locating assets in real time within a structure such as a warehouse. As illustrated in FIG. **13**B, the system **1335** utilizes RFID tags **1310** containing precise location data that are placed throughout a warehouse **1315**. The RFID tags **1310** can be placed using a predetermined standard for tag placement, or may be placed without using such a standard. RFID tags **1310** can be affixed to shelving, racks, flooring, overhead locations, etc., to precisely pinpoint the location and identity of a mobile asset **1325** carrying PDA **1360** (or other IRU or reader) while the mobile asset is moving though the warehouse. This asset and location tag data can then be relayed to a server via a wireless network. An application residing on the server receives the data and associates the asset with the current location in database **1330**. In the illustrated embodiment, the mobile asset **1325** comprises a forklift. In further embodiments, the mobile asset **1325** can comprise a cart, vehicle or other mobile entity within the warehouse.

In another embodiment of the invention, RFID tag **1310** is configured to support various search providers such as Mobile Local Search, Location-Based Search, Proximity Search, Spot Relevance, and other suitable location based search services. For example, the user of mobile device **1360** may want to search for directions to a point of interest. First, mobile device **1360** establishes communication with RFID tag **1310** and receives location data from RFID tag **1310**. Next, mobile device **1360** sends the location data received from RFID tag **1310** to the ViewPoint system **1320**. Similarly, the location data can be forwarded to one of the search providers or a service portal. Using the location data from the RFID tag **1310** as a reference point, the search provider or the ViewPoint system **1320** may find a the desired point of interest by matching the location information of RFID tag **1310** to points of interest stored in database **1330** or in the search providers' database. Location data from RFID tag **1310** may contain a street address of the building where RFID tag **1310** is located, or the precise location within a structure, such as a mall. This allows the ViewPoint system **1320** to more accurately locate a point of interest near the address provided by RFID tag **1310**. Additionally, the ViewPoint system **1320** can calculate the direction from the location of RFID tag **1310** to the point of interest and send the direction data to mobile device **1360**.

In a further embodiment, the ViewPoint system **1320** can be expanded to provide other information beyond location-based data to mobile devices **1350** and **1360** such as advertisement, inventory information, and product information, etc. Expanding on the example above, the user of a mobile device **1360** requests for the location of the nearest specific retail store, the ViewPoint system **1320** may compile advertisement data such as coupons and other sales promotions to send to mobile device **1360**.

To provide better customer service, the ViewPoint system **1320** may keep records of mobile device behavior such as purchase history and past searches. Records may be kept along with mobile device MAC address, serial number, or other identification data. In this way, The ViewPoint system **1320** may determine what type of goods the owner of mobile device **1360** usually purchases. For example, the ViewPoint system **1320** may send coupons or advertisements regarding a computer game if its determined that the user of mobile device **1360** often purchases computer games and gaming related products. It should be noted that the coupons or advertisements sent by the ViewPoint system **1320** may be audio, video, image, text, or any combination thereof.

The ViewPoint system **1320** may also send inventory related data to mobile device **1360** based on the purchase history of mobile device **1360**. In this way, the ViewPoint system **1320** may provide good customer service to the user of mobile device **1360**. For example, every time the user of mobile device **1360** makes a purchase, the ViewPoint system **1320** saves the purchase information into database **1330**. Information recorded may include the type of item purchased, price, and quantity, for example. If an clothing article is purchased, the ViewPoint system **1320** may also record the clothing article's style and size. Every time the user of mobile device **1360** purchases a product, a sale staff may ask for the user's address or other identification data. Alternatively, the user of mobile device **1360** may be identified whenever the user uses a credit card, check, or debit card. These data are recorded along with the user mobile device identification information. In this way, whenever the user of mobile device **1360** makes a purchase, the ViewPoint system **1320** records the purchase along with the identification information of mobile device **1360**. In one embodiment, purchases made through a point-of-sale equipment such as check out computers and credit/debit card machines may be uploaded to a transactional/behavioral database or databases **1330** and **1340** by the point-of-sale equipment. The information uploaded may include item purchased, price, and the customer identification data such as the identification number of mobile device **1360**. ViewPoint system **1320** may query these transactional data to customize data sent to mobile device **1360**.

For example, using the behavioral data associated with mobile device **1360**, the ViewPoint system **1320** may determine what type of shoes and shoe size the user of mobile device **160** typically purchases, for example. Once this determination is made, the ViewPoint system **1320** may send customized data to mobile device **1360**. In this context, customized data comprises data prepared by the ViewPoint system **1320** based on the analysis of the behavioral data of mobile device **1360**. For example, assume that mobile device **1360** is at a department store and RFID tag **1310** sends location data to mobile device **1360**. The location data contains information to indicate that mobile device **1360** is currently at the shoe department. Mobile device **1360** automatically sends its identification information and the location information to the ViewPoint system **1320**. Upon receipt of these data, the ViewPoint system **1320** sends a notification to a staff at the shoe department to alert the staff that the user of mobile device **1360** is in the shoe area. Additionally, the ViewPoint system **1320** looks up the behavioral data of mobile device **1360**. Since the ViewPoint system **1320** is aware that mobile device is currently at the shoe department, it can customize a data package with information relating to shoes to send to mobile device **1360**. For example, the ViewPoint system **1320** may send mobile device **1360** a list of all shoes currently available at the store with sizes 13, for example. In this example, the sizes of the shoes included in the data package sent to mobile device **1360** is based on the purchase history of mobile device **1360**.

FIG. **14** illustrates a method **1400** implemented by mobile devices **1350** and **1360** according to one embodiment of the present invention. Method **1400** starts at step **1410** in which mobile device **1350** or **1360** receives location data from RFID tag **1310**. This process is typically automatic and occurs whenever mobile device **1350** enters the communication range of RFID tag **1310**. In one embodiment, the user of mobile device **1350** may disable or enable communication with nearby RFID tags. As mentioned above, RFID tag **1310** may be a passive or an active tag. The mobile device **1350** will initiate the communication by sending out interrogation signals to RFID tag **1310**. Again, this only occurs if the user enables the mode that allows communication with nearby RFID tags.

In step **1420**, mobile device **1350** sends its identification information and the location data received from RFID tag **1310** to the ViewPoint system **1320**. This data package may be sent wirelessly using standard wireless communication protocols such as Bluetooth, HomeRF, or WiFi (wireless fidelity) or an active RFID tag with connection to a network. Upon receipt of the data package, the ViewPoint system **1320** uses the identification data to query database **1330** for information on mobile device **1350**. As mentioned above, information specific to mobile device **1350** such as purchase records can be used to tailor a promotional message or sales coupons to mobile device **1350**. Contemporaneous to querying database **1330**, the ViewPoint system **1320** may send a welcome message to mobile device based on received location data. For example, RFID tag **1310** may be placed at the entrance of the store. Accordingly, once the ViewPoint system **1320** receives the location data from mobile device **1350**, it knows that mobile device **1350** has just entered the store and accordingly sends a welcome message. Further, the ViewPoint system **1320** may send a notification via email, phone, or page, to a staff to notify that the user of mobile device **1350** is present.

After the ViewPoint system **1320** finishes querying database **1330** for information on mobile device **1350**, it compiles a data package to send to mobile device **1350**. The data package may include general advertisement materials, product info, or other information that the ViewPoint system **1320** determines may be of interest the user of mobile device **1320**. The data package may be audio, video, image, text or any of those combinations. As previously mentioned, the data package is based on the identification of the mobile device and the location data received from RFID tag **1310**. In this way, the ViewPoint system **1320** may customize the data sent to mobile device **1350**. In step **1430**, mobile device receives the above customized data. Alternatively, the data package is a general data package that is sent to every mobile device within its effective range.

In step **1440**, mobile device **1350** or **1360** presents the received data package from the ViewPoint system **1320** to the user of the device. This may be accomplished using a graphical user interface (GUI) on mobile device **1350**. Alternatively, mobile device **1350** may present the data package via a speaker if the data package contains audio information. In addition, the data package may be presented using a combination of image, audio, and video information.

FIG. **15** illustrates a method **1500** according to one embodiment of the present invention. Method **1500** begins at step **1505** where mobile device **1350** or RFID tag **1310** is detected. Once communication is established between mobile device **1350** and RFID tag **1310**, RFID tag **1310** sends location data to mobile device **1350**.

In step **1510**, mobile device **1350** registers itself with the ViewPoint system **1320**. Mobile device **1350** registers itself by sending its identification information and/or the location information from RFID tag **1310** to the ViewPoint system **1320**.

In step **1515**, the ViewPoint system **1320** queries database **1330** or database **1340** for information relating to mobile device **1350**. In step **1520**, the ViewPoint system determines if there is a pre-existing record for mobile device **1350**. If a record exists, the method **1500** proceeds to step **1540**. If there is no record, the method **1500** proceeds to step **1525**.

In step **1525**, the ViewPoint system **1320** creates a new record for mobile device **1350**. In step **1530**, the ViewPoint system **1320** sends a customized data package to the new user. The customized data package may include store hours, upcoming events, promotional materials, and/or a welcome message to welcome the new customer.

In step **1535**, the ViewPoint system **1320** updates database **1330** or database **1340** on the behavior of mobile device **1350**. For example, the ViewPoint system **1320** may monitor and record all purchases made by mobile device **1350**. The ViewPoint system **1320** may also monitor the mobile device's travel pattern, search history, etc., and record the activities into database **1330** and/or database **1340**. This allows the ViewPoint system **1320** to learn the behavior of mobile device **1350**, which will enable the ViewPoint system to better serve the user of mobile device **1350** when he/she returns to the store in the future.

If in step **1520**, a record is found for mobile device **1350**, then the method **1500** process to step **1540**. In step **1540**, the ViewPoint system **1320** notifies a staff of the store that mobile device **1350** is in the area. Since the identification of mobile device **1350** is known at this stage, the ViewPoint system **1320** may notify the appropriate staff in order to better serve the user of mobile device **1350**. Additionally, in step **1545**, the ViewPoint system **1320** may send a message customized specifically for the user of mobile device **1350**. For example, if the record shows that the user of mobile device **1350** is Mr. Smith, the ViewPoint system **1320** may send a welcome message that states "Welcome Mr. Smith." Additionally, the customized data package may include store hours, upcoming events, and promotional materials.

In step **1550**, the ViewPoint system **1320** performs a detailed query for behavioral data of mobile device **1350**. In step **1555**, the behavioral data is analyzed for patterns. In step **1560**, the ViewPoint system **1320** sends a second customized data package to mobile device **1350** based on the analysis of the behavioral data. The second customized data package may include promotional materials specifically tailored for mobile device **1350**. For example, if the purchase history of mobile device **1350** shows that tennis equipment is frequently purchased by the user of mobile device **1350**, then the ViewPoint system **1320** may send coupons or promotional materials relating to tennis to mobile device **1350**. It should be noted that step **1545** may be combined with step **1560**. In this way, mobile device **1350** only receives 1 comprehensive data package instead of several data packages.

In step **1565**, the ViewPoint system **1320** updates database **1330** and/or database **1340** on the behavior of mobile device **1350**. Similar to step **1535**, the ViewPoint system **1320** monitors and records all purchases made by mobile device **1350**. The ViewPoint system **1320** may also monitor the mobile device's travel pattern, search history, etc., and record these activities into database **1330** and/or database **1340**. Even though the method is described in the order shown, the steps of method **1500** may be performed in various orders without departing from the scope of the invention.

FIG. **16** illustrates yet another exemplary environment **1600** in which methods and systems for tracking shopping behavior may be implemented. Environment **1600** is a wireless network environment such as LAN, WAN, or other suitable wireless network. Similar to environment **1300**, environment **1600** may comprises a combination of a wireless network and a wired network. For example, a mobile device such as, for example, a interrogator relay unit **1610** may be wirelessly connected to a network **1605**. A server or traffic tracking system **1620** may be wirelessly or directly connected to network **1605** via POTS or other suitable wired network. In one embodiment, interrogator relay unit **1610** is a RF transmitter/receiver device configured both transmit and receive RF signals.

As shown, environment **1600** includes network **1605**, IRU **1610**, an RFID tag **1615**, traffic tracking system **1620**, a database **1625**, a point-of-sale terminal **1630**, a cart **1645**, and a shelf **1640**. In addition to other functionalities that will be described herein, environment **1600** incorporates all of the features of RFID system **100** as described above. Similarly, RFID tag **1615** incorporates all features previously described for RFID tag **130**.

In environment **1600**, a plurality of RFID tags **1615** may be distributed on shelf **1640**. RFID tags **1615** may be evenly or randomly distributed on shelf **1640**. For example, an RFID tag can be placed on shelf **1640** at every other 5 feet. The distance between each RFID tag can be adjusted based on the resolution of detection desired. In one embodiment, RFID tag **1615** is configured to respond to interrogation signals sent out by IRU **1610**. Once RFID tag **1615** detects the interrogation signal, it sends location information to IRU **1610**. The location information can be information about its location with respect to shelf **1640** or to a reference point in the store. The location information can include an aisle number, a section number, and other suitable location information. An example of location information is "Aisle 5, Section 4, Produce."

As mentioned, RFID tag **1615** may be evenly or randomly distributed within a shelf or a structure of the store (e.g., wall, floor, and fixture). The distance between each RFID tag **1615** may depend on the sensitivity of the IRU and RFID tag **1615**. The distance between each tag should be selected such that IRU **1610** is not confused as to its location because it has received too many responses from a plurality of RFID tags **1615**. For example, if the transmission range of the RFID tag **1615** is 1-2 feet, then the distance between each RFID tag **1615** may be as little as 2 feet or at a distance such that IRU **1610** only receives a maximum of 2 or 3 location information from different RFID tags **1615**. Generally, a high number of RFID tags will translate to a high tracking resolution. It should be noted that other methods can be implemented to adjust the resolution and sensitivity of IRU **1610** and RFID tag **1615**. For example, the output power of the interrogation signal can be adjusted to reduce or increase the range of the interrogation signal.

As shown in FIG. **16**, RFID tags **1615** are distributed on both sides of shelf **1640**. Shelf **1640** can be located in a store such as, for example, a grocery store, a department store, or an electronic store. In one embodiment, IRU **1610** can be placed on a shopping cart **1645** or basket. In this way, a travel pattern **1650** of IRU **1610** through the store may be tracked by traffic tracking system **1620** as the cart or basket is being used by a customer.

In operation, IRU **1610** transmits an interrogation signal which may be received by a nearby RFID tag **1615**. Once the interrogation signal is received, RFID tag **1615** sends its location information to IRU **1610**. In one embodiment, IRU **1610** transmits the received location information and identification information of the IRU to traffic tracking system **1620** and/or database **1625**. Preferably, IRU **1610** immediately transmits the received location information and the identification information immediately after it has received the location information from nearby RFID tag. In one embodiment, IRU **1610** also transmits timestamp data long with the location information. In this way, traffic tracking system **1620** may determine how long an IRU is located at a certain RFID tag. For example, traffic tracking **1620** may receive location data that comprises "Section 1, Bakery" at several consecutive timestamp intervals (e.g., 16:01, 16:02, 16:04, 16:05).

In one embodiment, IRU **1610** is configured to transmit interrogation signals at random intervals. Alternatively, IRU **1610** is configured to transmit interrogation signals at a predefined time intervals. In this embodiment, IRU **1610** can also be configured to send data to traffic tracking **1620** at a predefined time interval regardless of whether it has received location data from a nearby RFID tag. In one embodiment, IRU **1610** is configured to timestamp each location data received from an RFID tag. Alternatively, IRU **1610** may or may not timestamp the location data if it is configured to transmit its status at predefined intervals. If no location data has been received, IRU **1610** may transmit a 'no-data' to traffic tracking **1620**. In this way, each location data point stored in database **1625** can represent a time interval. Thus, time duration can be computed based strictly on the number of location data points.

Preferably, all data transmitted by IRU **1610** are stored in database **1625**. In this way, traffic tracking system **1620** may query database **1625** to generate a behavior report on a particular IRU using the IRU identification. In one embodiment, traffic tracking system **1620** is configured to generate a behavior report that includes a travel pattern (e.g., travel pattern **1650**) and a time duration report showing how long IRU **1610** is at a particular RFID tag **1615** or location of the store.

In one embodiment, IRU **1610** is configured to send its identification information to point-of-sale terminal **130** once it has determined that it is at the point-of-sale terminal. This can be accomplished by analyzing the location data received from RFID tag **1615**. AN RFID tag at point of terminal **1630** can have a unique identifier that allows IRU **1610** to recognize that it is at the point-of-sale terminal. In one embodiment, IRU **1610** is also configured to notify traffic tracking system **1620** that it is located point-of-sale terminal **1630**. In this way, traffic tracking system **1620** may wirelessly configure IRU **1610** to stop collecting location information from RFID tag **1615**. The location data collected at point-of-sale terminal **1630** can also be used as the last data point used to determine travel pattern/route **1650**.

In one embodiment, point-of-sale terminal **1630** transmits a point-of-sale data package to traffic tracking system **1620** after a sale transaction is completed. A point-of-sale data package may include purchaser information, items purchased information, coupon or discount program used, and the IRU's identification. Purchaser information may include a credit card, checking account, club membership information, or other suitable information that can identify a particular customer. Items purchased information may include names of items purchased, quantity purchased, price, and date and time of purchase. In this way, traffic tracking system **1620** can generate a shopping behavior report that may include statistics such as, for example, ten most frequently purchased items, average spending per transaction, traffic pattern the customer or the traffic pattern of the IRU being associated to the transaction, average time at various locations in the store, average time in the store, hours and day of week the customer usually visit the store, etc.

In one embodiment, environment **1600** includes an RFID tag on a consumer card (not shown) such as, for example, a club card (e.g. a grocery store saver's card) or a store credit card. In this embodiment, IRU **1610** can be configured to interrogate a nearby consumer card and to receive a customer information from the consumer card. The customer information can then be transmitted to traffic tracking system **1620**, which can associate the customer information with other information such as, for example, the current IRU identification information and information in the point-of-sale data package after the transaction is completed. In this way, traffic tracking system **1620** has multiple means for identifying an individual customer.

FIG. **17** illustrates a high-level process flow **1700** implemented by a system and method for tracking shopping behavior according to one embodiment of the present invention. As illustrated in FIG. **17**, process flow **1700** starts at step **1710**.

In step **1710**, an interrogation signal is emitted. In one embodiment, a plurality of interrogation signals is emitted by IRU **1610** at a random or predetermined intervals. In response to the interrogation signal, any RFID tag within the transmission range of the interrogation signal is configured to respond by emitting a response signal. The response signal may include information regarding the location of the RFID tag with respect to a reference point.

In step **1720**, the location data is received by IRU **1610**. In step **1730**, the location information is transmitted to a remote server along with identification information of the IRU. The identification information and the location data are then stored in a database such as, for example, database **1625** while also maintaining their association.

In step **1740**, a behavior report is generated using the information stored in database **1625**. In one embodiment, the behavior report includes travel pattern of the IRU with respect to a plurality of RFID tags positioned throughout a structure such as a store.

FIG. **18** is a diagram that illustrates a process flow **1800** that can be implemented by a system and method for tracking shopping behavior according to one embodiment of the present invention. In step **1810**, location data from RFID tag **1615** is received by IRU **1610** in response to IRU **1610** interrogation signal.

In step **1820**, timestamp data is created for the received location data. In one embodiment, each location data is preferably timestamped. Timestamp data may be created and appended to the location data. Alternatively, timestamp data can be separately created and associated to the location data received. In one embodiment, IRU **1610** is configured to timestamp the received location data. Preferably, the received location data is timestamped immediately after it is received.

In step **1830**, IRU **1610** is configured to transmit the timestamp data, the location data, and the identification data of the IRU to traffic tracking system **1620**, which then stores the data in database **1625**.

In step **1840**, the time duration of an IRU being within the transmission range of a particular RFID tag is calculated. To illustrate, let us assume an RFID tag with location data of "Aisle 6, Section 2, Bread," which will be referred to as the bread RFID tag. Let us further assume that the IRU identification information is "IRU No. 2." To calculate the time IRU **1610** is within the transmission range of the bread RFID tag, traffic tracking system **1620** may query database **1625** for data associated with IRU No. 2. The query results may be as follows:

| IRU ID | RFID Location Data | Time |
|---|---|---|
| No. 2 | Aisle 6, Section 2, Bread | 8/2/07 13:06:30 |
| No. 2 | Aisle 6, Section 2, Bread | 8/2/07 13:07:00 |
| No. 2 | Aisle 6, Section 2, Bread | 8/2/07 13:07:30 |
| No. 2 | Aisle 6, Section 2, Bread | 8/2/07 13:08:00 |
| No. 2 | Aisle 6, Section 3, Deli | 8/2/07 13:08:30 |

Using the above query results, traffic tracking system **1620** may then determine that IRU No. 2 was at the bread section for approximately 1.5 minutes. As shown, the time resolution depends on the intervals of the data points. The time resolution can be adjusted by adjusting the frequency of data sampling and collection in steps **1810-1830**. In one embodiment, traffic tracking system **1620** is configured to determine the time duration of an IRU at each RFID tag.

In step **1850**, the route or path of an IRU is determined. In one embodiment, a graphical layout of preferably all RFID tags is produced and the route of a an IRU is overlaid on top of the graphical layout. In this way, the route of an IRU can be visually perceived. An example of a visual representation of an IRU route and the layout of RFID tags is shown in FIG. **1**. In one embodiment, the route of an IRU is determined by querying database **1625** for data associated with the IRU of interest. Each data point in the query results can then be displayed and connected together to form a representation of the travel path. In one embodiment, the end of the route can be determined by detecting when the IRU is at a point-of-sale terminal or other designated area for a predetermined amount of time. For example, traffic tracking system **1620** may determine that a cart has been abandoned if it has been in the same location for more than 30 minutes. As another example, traffic tracking system **1620** may determine that the path of a cart has ended when the cart reached a point-of-sale terminal and has been there for more than 3 minutes. The beginning of a path may be determined once a cart enters a zone such as, for example, the front door, or the produce area.

In step **1860**, a route and time spent at preferably each data point (RFID location) report is generated. In one embodiment, a graphical report is generated. FIG. **19** illustrates an example graphical report generated by traffic tracking system **1620** according to one embodiment of the present invention. As shown in FIG. **19**, a plurality of RFID tags **1615** is distributed throughout a store. In step **1860**, path **1910** is generated by querying database **1625** for data associated to cart **1645**. In step **1860**, a plurality of dots is used to represent data points of the query. Each dot is approximately placed based on the location data of the RFID tag. In one embodiment, time duration can be displayed next to the dot. Alternatively, the size of the dot can varies with respect to the time duration spent at the dot. In this way, one can perceive the travel path of the IRU and the time spent at each location by observing the size of each dot relative to each other. For example, a dot **1915** is relatively small than a dot **1920**. This indicates that cart **1645** spent more time at dot **1920** than at dot **1915**. FIG. **19** also indicates that cart **1645** spent the most time at dot **1930**, which is at a point-of-sale terminal. In one embodiment, the size of the line that traces the path of cart **1645** can varies to represent the time spent near the closest data point. For example, line size immediate to the right of dot **1920** can be large and become progressively smaller as it approaches **1925**.

FIG. **20** is a diagram that illustrates a process flow **2000** that can be implemented by a system and method for tracking shopping behavior according to one embodiment of the present invention. It should be noted that process flow **2000** can be used in conjunction with process flow **1800** to collect additional data. Referring now to FIG. **20**, in step **2010**, interrogation signals are transmitted at a constant interval. The period or interval may be 5 or 10 seconds for example. In one embodiment, traffic tracking system **1620** can adjust the frequency in which IRU **1610** is emitting interrogation signal. In step **2020**, location data from a nearby RFID tag is received.

In step **2030**, IRU **1610** transmits the location information from the nearby RFID tag along with the IRU identification information. In one embodiment, step **2030** is preferably performed immediately after step **2020**.

In step **2040**, the time duration of an IRU at one or more RFID tags is calculated. This may be done by keeping track of the number of consecutive data points as having the same location data. For example, if the period is 5 seconds and there are 7 consecutive data points that have the same location data from a single RFID tag, it follows that the IRU is near that particular RFID tag location for at least 35 seconds. In one embodiment, traffic tracking **1620** is configured to calculate at least the following statistics: the time duration an IRU is near (located within transmission range of the tag) each RFID tag; the total time duration for each RFID tag; and average time each IRU is near each RFID tag. In step **2050**, a report is generated. In one embodiment, the report generated in step **2050** is similar to the report generated in step **1860**.

FIG. **21** is a diagram that illustrates a process flow **2100** that can be implemented by a system and method for tracking shopping behavior according to one embodiment of the present invention. It should be noted that process flow **2100** can be used in conjunction with process flows **1800** and **2000** to collect additional data. Referring now to FIG. **21**, in step **2110**, an interrogation signal is transmitted. In one embodiment, the transmitter or interrogator is configured to send out a customized interrogation signal to solicit information from an RFID tag located on a consumer card such as, for example, a club card, a saver card, a store credit card, etc. In one embodiment, step **2110** is only performed at the beginning of the tracking process and only after the IRU is located at a certain zone such as, for example, the front entrance or the produce section.

In step **2120**, customer information is received from the RFID tag on the consumer card. The customer information may include a membership number, a telephone number, name, and address, etc. In step **2030**, the customer information and the IRU identification information are sent to traffic tracking System **1620**. In one embodiment, step **2030** is preferably done immediately after step **2120**.

In step **2140**, the customer information is associated with the IRU identification information. This enables traffic tracking system **1620** to equate the behavior of the IRU to the behavior of the customer. In step **2150**, a behavior report is generated. In one embodiment, the customer information includes gender and age information. Thus, the behavior report may include path of travel for a selected customer. The behavior report may include other statistics broken down by age group, gender, and other demographics, such as, for example, most visited location of a store for males and females, and most frequently used path of travel by 25-30 years old, etc.

In one embodiment, steps **2110-2120** can be repeated when the IRU is located at a point-of-sale terminal. In this way, the customer information data can be compared and verified prior to transmitting the customer data to traffic tracking system **1620**. If, for example, the same customer information is detected during the first and second iterations of steps **2110-2120**, then the customer information can be assumed to be the rightful owner of the cart. This helps reduce the chance of reading in stray data from a customer card that happens to be located within the transmission range of the transmitter.

FIG. **22** is a diagram that illustrates a process flow **2200** that can be implemented by a system and method for tracking shopping behavior according to one embodiment of the present invention. It should be noted that process flow **2200** can be used in conjunction with process flows **1800**, **2000**, and **2100** to collect additional data. Referring now to FIG. **22**, in step **2210**, a customer information and a transaction related information is transmitted to traffic tracking system **1620** after a sale transaction has been completed at a point-of-sale terminal. The customer information transmitted by a point-of-sale terminal may include credit card number, address, name, sex, age, checking account number, etc. The customer information may be obtained from the customer's method of payment and use of a club or membership card. The transaction related information may include items purchased, quantity, price of each item, total price of purchase, coupon or discount used, etc.

In step **2220**, the customer information and the transaction related information is associated with the IRU in the cart currently located at the point-of-sale terminal. In this way, traffic tracking **1620** may associate the customer information and the transaction related information to the IRU identification. This also enables traffic tracking **1620** to associate data collected during process flows **1800**, **2000**, **2100**, and **2200** with one another. In step **2230**, a shopping behavior report is generated. In one embodiment, step **2230** includes one or more report features of steps **1860**, **2050**, and **2150**. In one embodiment, the behavior report generated by step **2230** may include statistics such as, for example, average money spent per transaction by age, type of product purchased by gender, and relationship between the average money spent per transaction and time spent in the store, etc.

According to the invention, a base unit may consist of hardware and software that monitors and communicates with smart IRUs **714** or other mobile devices **1350** and **1360** using wireless communication technologies. Base unit operation may be configurable, allowing it to be programmed to operate in a variety of RF and communication modes. Base unit software runs on computers (including but not limited to laptops) and other smart devices such as PDAs, Blackberries and other portable computer-based devices. Base unit hardware may interface to host computer devices using industry standard interfaces. Base unit dissemination service supports both push and pull requests for information from external systems, users and display devices. Base unit data management service supports the collection or ingest, storage, logging and integration of data from RFID entity location systems and from external systems. By way of example, external systems may include GIS systems, GPS and other tracking systems, and data systems used by RFID entity location system users. A complete log of data events and quality of service data is maintained for future reference.

The above-described embodiments can feature the integration of various smart devices with an IRU. Referring to FIG. **23**A, an intelligent shopping unit **2300** can comprise a cart **2310** having a smart device **2320** for communicating with fixed reader unit (IRU **2330**). The smart device **2320** may include one or more third party Mobile Applications for advertising, tracking, recipes, nutrition information, coupons, specials, etc. Such applications can be developed by various parties including, but not limited to: retail vendors, hardware vendors, independent entities, and commercial entities. These parties may provide the applications on the Internet via Apple's App Store, Google's Play Store, Microsoft's Windows Phone Store, Open Sources, and the like. In the illustrated embodiment, IRU **2330** comprises a fixed IRU **2330** (e.g., Bluetooth) located at any position on the cart **2310**. The cart **2310** can include a smart device holder **2340** for safely holding the smart device **2320** during use. The IRU **2330** can include any or all of the features described with respect to the IRUs described herein. For example, the IRU **2330** can read the location on various RFID tags including location tags and/or product tags. Additionally, IRU **2330** interfaces with the applications for advertising, tracking, recipes, nutrition information, coupons, specials, etc.

FIG. **23**B depicts intelligent shopping unit **2350** including a cart **2310** having a smart device **2320** for communicating with portable reader unit (IRU **2360**). The cart **2310** can include a portable IRU holder **2370** for safely holding the IRU **2360** during use. Similar to the previous embodiment, the IRU **2360** can include any or all of the features described with respect to the IRUs described herein. IRU **2360** interfaces with the Mobile Applications for advertising, tracking, recipes, nutrition information, coupons, specials, etc.

FIG. **23**C depicts intelligent shopping unit **2380** including a cart **2310** having a smart device **2385** including integrated reader unit (IRU **2390**). The cart **2310** can include smart device holder **2395** for safely holding the smart device **2385** during use. Like previous embodiments, the IRU **2390** can include any or all of the features described with respect to the IRUs described herein. IRU **2360** interfaces with the Mobile Applications for advertising, tracking, recipes, nutrition information, coupons, specials, etc.

The presentation service formats, integrates and adjusts data for display based on the user's needs and the characteristics of the display device. In addition, the presentation service allows information to be displayed in a manner adjusted for the physical size of the display. The base unit collection service ingests and manages both dynamic and static information.

Referring now to FIG. **24**, computing module **2400** may represent, for example, computing or processing capabilities found within desktop, laptop and notebook computers; handheld computing devices (PDA's, smart phones, cell phones, palmtops, etc.); mainframes, supercomputers, workstations or servers; or any other type of special-purpose or general-purpose computing devices as may be desirable or appropriate for a given application or environment. Computing module **2400** might also represent computing capabilities embedded within or otherwise available to a given device. For example, a computing module might be found in other electronic devices such as, for example, digital cameras, navigation systems, cellular telephones, portable computing devices, modems, routers, WAPs, terminals and other electronic devices that might include some form of processing capability.

Computing module **2400** might include, for example, one or more processors, controllers, control modules, or other processing devices, such as a processor **2404**. Processor **2404** might be implemented using a general-purpose or special-purpose processing engine such as, for example, a microprocessor, controller, or other control logic. In the illustrated example, processor **2404** is connected to a bus **2402**, although any communication medium can be used to facilitate interaction with other components of computing module **2400** or to communicate externally.

Computing module **2400** might also include one or more memory modules, simply referred to herein as main memory **2408**. For example, preferably random access memory (RAM) or other dynamic memory, might be used for storing information and instructions to be executed by processor

2404. Main memory 2408 might also be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor 2404. Computing module 2400 might likewise include a read only memory ("ROM") or other static storage device coupled to bus 2402 for storing static information and instructions for processor 2404.

The computing module 2400 might also include one or more various forms of information storage mechanism 2410, which might include, for example, a media drive 2412 and a storage unit interface 2420. The media drive 2412 might include a drive or other mechanism to support fixed or removable storage media 2414. For example, a hard disk drive, a floppy disk drive, a magnetic tape drive, an optical disk drive, a CD or DVD drive (R or RW), or other removable or fixed media drive might be provided. Accordingly, storage media 2414 might include, for example, a hard disk, a floppy disk, magnetic tape, cartridge, optical disk, a CD or DVD, or other fixed or removable medium that is read by, written to or accessed by media drive 2412. As these examples illustrate, the storage media 2414 can include a computer usable storage medium having stored therein computer software or data.

In alternative embodiments, information storage mechanism 2410 might include other similar instrumentalities for allowing computer programs or other instructions or data to be loaded into computing module 2400. Such instrumentalities might include, for example, a fixed or removable storage unit 2422 and an interface 2420. Examples of such storage units 2422 and interfaces 2420 can include a program cartridge and cartridge interface, a removable memory (for example, a flash memory or other removable memory module) and memory slot, a PCMCIA slot and card, and other fixed or removable storage units 2422 and interfaces 2420 that allow software and data to be transferred from the storage unit 2422 to computing module 2400.

Computing module 2400 might also include a communications interface 2424. Communications interface 2424 might be used to allow software and data to be transferred between computing module 2400 and external devices. Examples of communications interface 2424 might include a modem or softmodem, a network interface (such as an Ethernet, network interface card, WiMedia, IEEE 802.XX or other interface), a communications port (such as for example, a USB port, IR port, RS232 port Bluetooth® interface, or other port), or other communications interface. Software and data transferred via communications interface 2424 might typically be carried on signals, which can be electronic, electromagnetic (which includes optical) or other signals capable of being exchanged by a given communications interface 2424. These signals might be provided to communications interface 2424 via a channel 2428. This channel 2428 might carry signals and might be implemented using a wired or wireless communication medium. Some examples of a channel might include a phone line, a cellular link, an RF link, an optical link, a network interface, a local or wide area network, and other wired or wireless communications channels.

In this document, the terms "computer program medium," "computer readable medium," and "computer usable medium" are used to generally refer to media such as, for example, memory 2408, storage unit 2420, media 2414, and channel 2428. These and other various forms of computer program media or computer usable media may be involved in carrying one or more sequences of one or more instructions to a processing device for execution. Such instructions embodied on the medium, are generally referred to as "computer program code" or a "computer program product" (which may be grouped in the form of computer programs or other groupings). When executed, such instructions might enable the computing module 2400 to perform features or functions of the present invention as discussed herein.

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not of limitation. Likewise, the various diagrams may depict an example architectural or other configuration for the invention, which is done to aid in understanding the features and functionality that can be included in the invention. The invention is not restricted to the illustrated example architectures or configurations, but the desired features can be implemented using a variety of alternative architectures and configurations. Indeed, it will be apparent to one of skill in the art how alternative functional, logical or physical partitioning and configurations can be implemented to implement the desired features of the present invention. Also, a multitude of different constituent module names other than those depicted herein can be applied to the various partitions. Additionally, with regard to flow diagrams, operational descriptions and method claims, the order in which the steps are presented herein shall not mandate that various embodiments be implemented to perform the recited functionality in the same order unless the context dictates otherwise.

Although the invention is described above in terms of various exemplary embodiments and implementations, it should be understood that the various features, aspects and functionality described in one or more of the individual embodiments are not limited in their applicability to the particular embodiment with which they are described, but instead can be applied, alone or in various combinations, to one or more of the other embodiments of the invention, whether or not such embodiments are described and whether or not such features are presented as being a part of a described embodiment. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments.

Terms and phrases used in this document, and variations thereof, unless otherwise expressly stated, should be construed as open ended as opposed to limiting. As examples of the foregoing: the term "including" should be read as meaning "including, without limitation" or the like; the term "example" is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof; the terms "a" or "an" should be read as meaning "at least one," "one or more" or the like; and adjectives such as "conventional," "traditional," "normal," "standard," "known" and terms of similar meaning should not be construed as limiting the item described to a given time period or to an item available as of a given time, but instead should be read to encompass conventional, traditional, normal, or standard technologies that may be available or known now or at any time in the future. Likewise, where this document refers to technologies that would be apparent or known to one of ordinary skill in the art, such technologies encompass those apparent or known to the skilled artisan now or at any time in the future.

The presence of broadening words and phrases such as "one or more," "at least," "but not limited to" or other like phrases in some instances shall not be read to mean that the narrower case is intended or required in instances where such broadening phrases may be absent. The use of the term "module" does not imply that the components or functionality described or claimed as part of the module are all configured in a common package. Indeed, any or all of the various components of a module, whether control logic or other components, can be combined in a single package or separately maintained and can further be distributed in multiple groupings or packages or across multiple locations.

What is claimed is:

1. A method for tracking an interrogator relay unit (IRU) associated with a mobile asset within a structure, comprising:

integrating one or more RFID tags within building materials within the structure;

emitting an RF interrogation signal using the IRU;

receiving, at the IRU, location data from one or more RFID tags in response to the RF interrogation signal; and

transmitting the location data, an identification information of the IRU, and timestamp data to a remote server using the IRU;

wherein the building materials are selected from the group consisting of: wall materials, rough building materials, flooring materials, and ceiling materials;

wherein integrating the one or more RFID tags comprises integrating the RFID tags into the building materials at a manufacturing plant by placing the RFID tags at predetermined intervals within the building materials in accordance with a standard format.

2. The method of claim 1, further comprising pre-programming the RFID tags with unique information at the manufacturing plant.

3. The method of claim 1, wherein integrating the one or more RFID tags comprises placing the RFID tags within the building materials at selected locations based upon a predetermined standard.

4. A system for tracking a mobile asset within a structure, comprising:

one or more RFID tags integrated within building materials of the structure; and

an interrogator relay unit (RU) that emits an RF interrogation signal;

wherein the IRU receives location data from one or more RFID tags in response to the RF interrogation signal;

wherein the IRU transmits the location data, an identification information of the IRU, and timestamp data to a remote server;

wherein the building materials are selected from the group consisting of: wall materials, rough building materials, flooring materials, and ceiling materials;

wherein the one or more RFID tags are integrated into the building materials at a manufacturing plant by placing the RFID tags at predetermined intervals within the building materials in accordance with a standard format.

5. The system of claim 4, wherein the RFID tags are preprogrammed with unique information at the manufacturing plant.

6. The system of claim 4, wherein the one or more RFID tags are placed at selected locations based upon a predetermined standard.

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UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION



PATENT NO. : 9,111,157 B2
APPLICATION NO. : 13/889184
DATED : August 18, 2015
INVENTOR(S) : James Christopher

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 28, line 5: "(RU)" should be -- (IRU) --.

Signed and Sealed this
Twenty-ninth Day of December, 2015

Michelle K. Lee
*Director of the United States Patent and Trademark Office*